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BATHYBIUS AND THE MONERS.[1]

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"BATHYBIUS, about which so much has been said, has no existence; the assumption of its existing rested on illusions. It will be the same with the rest of the Moneres; these supposed primordial organisms, too, will prove to be the product of erroneous observation. So has one of the main supports of the modern development doctrine fallen, and it will yet be found that all its other supports rest upon illusions and on error. The whole fabric of Darwinism is simply an air-castle, the theory of natural selection is a soap-bubble, and the doctrine of descent is not true."

Such is the gist of many an article published during the past year in all sorts of periodicals. Simply and solely from the supposed non-existence of Bathybius it is rashly inferred that there is no such thing at all as Moneres, and that the doctrine of evolution is badly hit. This assertion is of course made with most gusto by the opponents of the development theory. The clergy is already rejoicing over the utter downfall of the theory of descent. But even among the adherents of the theory of evolution, the non-existence of Bathybius is held to be proved, and from this fact a series of conclusions is drawn which suggests more or less weighty objections against some of the main principles of Darwinism. These circumstances, as also the confusion of the public mind as to the actual state of the case, have induced me to consider the Moneres question with special reference to Bathybius. It would appear to be specially my right, nay, even my duty, to discuss this question, inasmuch as it was my dubious luck to have stood godfather to this "ill-famed primordial slime of the sea-depths." When, in 1868, my friend Thomas Huxley gave

[1] Translated from the German, by J. Fitzgerald, A. M.

to it in baptism the name *Bathybius Haeckelii*, he of course could not have foreseen that the poor neophyte would, like another Icarus, in a very short time become a biological celebrity, ascending to the heaven of terrestrial fame, and then before the end of its first decennium tumbling down into the gloomy Hades of mythology. Let us see, then, whether it is really dead, and whether it has ever existed at all. And supposing we have to admit its merely mythological apparition-existence, let us see what consequences result for the Moneres.

I. *History of the Moneres.*—In the spring of 1864 I observed in the Mediterranean, at Villafranca, near Nice, little floating globules of slime, one millimètre or half a line in diameter, which interested me very much. Under the microscope each of these globules looked like a little star, its centre consisting of a far smaller, structureless globule, while from the outer surface radiated several thousand exceedingly fine threads. Close examination with high powers showed that the whole body of the star-shaped thing consisted of simple albuminous cell-substance—*sarcode*, or *protoplasm;* and that the threads radiating on all sides from the surface were not permanent organs, but constantly variable, in number, size, and shape. They were seen to be changing and non-persistent processes of the central protoplasmic body, like the "false feet," or pseudopodia, which constitute the only organs of the Rhizopods. But while in the Rhizopods cell-nuclei are scattered through the protoplasm, and hence their bodies, morphologically considered, are made up of one or of many cells, nothing of the kind is to be seen in the protoplasmic globules observed at Villafranca. For the rest, no difference was to be found between the two with respect either to the motions of the filaments or to the manner in which they were employed as organs of touch for sensation, or as organs of nutrition for taking in food. To complete the natural history of the little protoplasm-globule, which I had studied with great minuteness, all that was still needed was a knowledge of its mode of propagation. In this, too, I was finally successful. After some time the little creature broke up into two halves by simple division, and each of these went on living like the original one. Thus I had learned the whole life-cycle of what I had to regard as one of the simplest organisms conceivable, and I gave it, in recognition of its fundamental significance, the name of *Protogenes primordialis*, "first-born of primeval time." An accurate description of it was published by me in vol. xv. of the *Zeitschrift für wissenschaftliche Zoologie* (p. 360, Plate XXVI., Figs. 1 and 2).

The very next year two distinct, extremely simple organisms, very closely resembling Protogenes, were described by the distinguished microscopist Cienkowski. In vol. i. of the *Archiv für mikroskopische Zoologie* (p. 203, Plates XII.–XIV.) he published very interesting "Contributions to the Knowledge of Monads." Among the various Protista here associated by Cienkowski under the old, ambiguous term

"Monads" occur two microscopic inhabitants of fresh water, which in the perfectly simple and structureless constitution of their unnucleated, radiate protoplasmic body resemble Protogenes—the genera Protomonas (*Monas amyli*) and Vampyrella (the latter in three different species); they differ, however, from Protogenes in their mode of propagation. Whereas Protogenes, after it has grown to a certain size, does not gain any further increase of mass, but directly breaks up into two fragments, Protomonas and Vampyrella retract their rays, and pass into the inactive state, and meanwhile the little protoplasmic globule becomes encysted, or surrounded with an envelope (cyst). While so encysted, Protomonas breaks up into a great number of smaller globules, and Vampyrella into four fragments (tetraspores). All of these afterward become free, and by a simple process of growth are developed into the perfect form.

In the mean time I had myself observed, in fresh water at Jena, a fourth allied genus of extremely simple organisms, in all respects like the common Amœba, but distinguished from it by having no cell-nucleus, and no contractile vesicular envelope; hence I named it *Protamœba primitiva*. While in the first-named three slime-globules (Protogenes, Protomonas, and Vampyrella) numerous filaments radiate from the entire surface of the central protoplasmic body, in Protamœba, on the contrary, just as in the common Amœba, there are only a few short, finger-shaped processes, which are constantly changing, being now retracted, and again pushed out in some other place. When Protamœba has, by taking in food—which operation it performs after the manner of Amœba—attained a certain size, it breaks up by division into two parts. I first published my observations of Protamœba in the "Generelle Morphologie," vol. i., p. 133. Afterward I published figures of *Protamœba primitiva*, which are to be found in my "Natural History of Creation," sixth German edition, p. 167, and in my "Anthropogenie," third edition, p. 414.

Backed by these observations, which were still further prosecuted afterward by other investigators, and also by myself, I, in 1866, in the "Generelle Morphologie," established a special class, that of Moneres (i. e., *simple*), for all these organisms of most simple constitution. In the first volume of that work I wrote as follows:

"In order clearly to distinguish from all other organisms made up of heterogeneous parts these simplest and most imperfect of all organisms, wherein neither the microscope nor chemical reagents can detect any differentiation of the homogeneous plasmic body, we give them, once for all, the name of *Moneres*, or simple organisms. Surely, if we would explain life; if we would deduce it from falsely so-called 'dead matter;' if we would fill up the chasm between organisms and the inorganic world—we must needs give special attention to these very interesting but hitherto quite neglected organisms, and lay the greatest stress upon their exceedingly simple morphological constitution, which nevertheless is entirely consistent with the discharge of all the essential functions of life. Inasmuch as in these homogeneous living things no trace is to be discov-

ered of different morphological constituents, of 'organs;' but, on the contrary, as all the molecules of the structureless carbon compound of the living albumen of which they consist are equally capable of performing the various life-functions, it is plain that the idea of an organism can be educed only dynamically or physiologically from vital movement, and not statically or morphologically from the composition of the body out of 'organs.'"

For some years after this the circle of our experiences with these strange "organisms without organs" was considerably widened. During my voyage to the Canary Islands in 1866–'67 I very naturally directed my whole attention to these organisms, and was so fortunate as to discover many new forms of Moneres. On the white calcareous shells of a remarkable Cephalopod (*Spirula Peronii*), found in thousands on the coasts of the Canaries, I have sometimes noticed numerous little red points, which under the magnifying-glass looked like ornamental stars, and, when highly magnified, like orange-red protoplasmic disks or globules, from the circumference of which radiated numerous tree-shaped filaments, with branches. Closer observation showed that these (comparatively colossal) protoplasmic bodies, too, were unnucleated and structureless, and that they propagated after the same manner as Protomonas, the globular, encysted body breaking up into a great number of little fragments. To this new genus of Moneres I gave the name of *Protomyxa aurantiaca*, and it is figured in Plate I. of the "Natural History of Creation." I then, during the same year (1867), found a like magnificent Moneres form in the mud of the harbor of Puerto del Arrecife, the port-town of the island of Lanzarote, and to it gave the name of *Myxastrum radians*. Its distinguishing mark is this, that the fragments or spores into which the globular body breaks up in the act of propagation arrange themselves in lines radiating from the centre of the globule, and exude spindle-shaped, siliceous envelopes, from which the young Moneres afterward drops out.

On the strength of all these observations, I, in 1868, published in the *Jenaische Zeitschrift für Naturwissenschaft* an extended "Monograph of the Moneres" (vol. iv., p. 64, Plates II. and III.). In this monograph both my own observations and those of others are set forth at length and discussed. At that time the number of known genera of Moneres was seven. By later observations it has been increased to sixteen, as is stated by me in my "Supplement to the Monograph of the Moneres" (*Jenaische Zeitschrift für Naturwissenschaft*, 1877, vol. vi., p. 23). The differences between these Moneres come simply from the fact that the soft, slimy mass expands and moves in different forms, and that the asexual propagation (by division, spore-formation, etc.) takes place in different ways.

II. *History of Bathybius.*—The great interest possessed by the Moneres morphologically as well as physiologically was further heightened when, in 1868, the foremost zoölogist of England, the celebrated

Thomas Huxley, described, in the *Journal of Microscopical Science* (vol. viii., new series, p. 1, Plate IV.), a new and quite peculiar species of Moneres, giving it the name of *Bathybius Haeckelii*. Unlike the rest of the Moneres, this Bathybius had included in it certain peculiarly-formed microscopic, calcareous corpuscles—coccospheres and coccoliths; but its formless masses of protoplasm, of very different sizes, were said to cover in enormous quantities the profoundest abysses of the sea, from 5,000 to 25,000 feet depth. With this formless primordial organism of the simplest kind, which, occurring in thousands of millions, covers the sea-bottom with a living layer of slime, a new light seemed to be thrown upon one of the most difficult and most obscure problems of the history of creation—namely, the question of the origin of life upon the earth. With Bathybius, the ill-famed "Urschleim" (primordial slime) appeared to have been found, of which it had been prophetically affirmed, fifty years before, by Oken, that from it was sprung the whole world of organisms, and that this "Urschleim" itself had sprung from inorganic matter at the sea-bottom in the course of planetary development.

The deep-sea ooze containing the masses of Bathybius was first discovered during the deep-sea soundings made in 1857 for the Atlantic cable. The Atlantic Telegraph Plateau, which stretches from Ireland to Newfoundland at a mean depth of 12,000 feet, was found to be covered everywhere with a peculiar gray, very finely-pulverized ooze. This ooze was remarkable for its tough, sticky nature, and under the microscope showed masses of little calcareous-shelled Rhizopods, particularly Globigerinæ, and also, as one of its main constituents, those minute corpuscles known as coccoliths. But it was not till eleven years later, in 1868, that Huxley, with the aid of a very powerful microscope, made a new and thorough investigation of this ooze, calling in also the aid of chemical analysis. He discovered the naked, free, formless protoplasm-masses, which, together with the Globigerinæ and the coccoliths, make up the great bulk of the ooze. "These masses are of different sizes, some being visible to the naked eye, others extremely minute. Subjected to microscopical analysis, they showed, imbedded in a transparent, colorless, structureless matrix, nuclei, coccoliths, and occasionally foreign bodies."

Living Bathybius was first observed in 1868, by Sir Wyville Thomson and Prof. William Carpenter, two practised and sagacious zoölogists, during a deep-sea exploring expedition to the North Atlantic, in the war-ship Porcupine. Of the living deep-sea ooze they write: "This ooze was actually living; it collected in lumps as though albumen had been mixed with it; and under the microscope the sticky mass was seen to be living sarcode" (*Annals and Magazine of Natural History*, 1869, vol. iv., p. 151); and Sir Wyville Thomson, in his very interesting work, "The Depths of the Sea," second edition, 1874, p. 410, adds:

"In this dredging [Globigerina-ooze taken at the depth of 2,435 fathoms in the bay of Biscay], as in most others in the bed of the Atlantic, there was evidence of a considerable quantity of soft gelatinous organic matter, enough to give a slight viscosity to the mud of the surface layer. If the mud be shaken with weak spirits of wine, fine flakes separate like coagulated mucus; and if a little of the mud in which this viscid condition is most marked be placed in a drop of sea-water under the microscope, we can usually see, after a time, an irregular network of matter resembling white-of-egg, distinguishable by its maintaining its outline, and not mixing with the water. This network may be seen gradually altering in form, and entangled granules and foreign bodies change their relative positions. *The gelatinous matter is therefore capable of a certain amount of movement, and there can be no doubt that it manifests the phenomena of a very simple form of life.*"

My own researches on Bathybius-ooze had to do, like those of Huxley, only with dead substance in alcohol. The bottle in which it had been sent to me from the Faroe Islands bore this label: "Dredged of Prof. Thomson and Dr. Carpenter with the steamer Porcupine, in 2,435 fathoms. 22. July 1869.—Latitude 47° 38′, longitude 12° 4′." Thus this Bathybius-ooze was the same on which the observers named above had made their investigations of the amœboid movements. The results of my own investigations I have stated fully in my "Beiträge zur Plastiden-Theorie" (II. "Bathybius and the Free Protoplasm of the Sea-Depths," *Jenaische Zeitschrift für Naturwissenschaft*, 1870, vol. v., p. 499, Plate XVII.). The eighty figures I there give of the different formless protoplasm-masses of Bathybius, and of the little calcareous bodies included in the same, were copied with the utmost exactness from very highly-magnified images of those organisms taken with the aid of the camera lucida. Some of the figures have also been used in my paper on "Life in the Profoundest Depths of the Sea," which was published in 1870, in the Virchow-Holzendorff Collection (No. 110).

This specimen of Bathybius-ooze, which had been very well preserved in strong alcohol, I examined as minutely as possible, employing the newest methods of research, and in particular the excellent method—not employed by Huxley in his investigation—of staining with carmine and iodine, my purpose being, above all, to determine more accurately the quantity and quality of the amorphous protoplasmic matter. This albuminous substance, which was reddened by carmine, was very evenly distributed through the ooze, and in most of the specimens examined constituted at least one-tenth to one-fifth of the whole volume; in many instances it was as much as one-half. The same protoplasmic masses which, on treatment with carmine, became of a more or less deep-red tint, took from iodine and pure nitric acid a yellow color; and with other chemical reagents they exhibited precisely the same properties as the protoplasm of animal and vegetal cells. The form of most of the little masses was irregular, roundish, or provided with obtuse processes resembling those of an Amœba;

others took the form of irregular reticulations of sarcode, like those of the Myxomycetæ.

Whether the little calcareous frustules—coccoliths and coccospheres—which occur so abundantly in Bathybius-ooze, both within and between the protoplasm-masses, actually belong to it or not, I was unable to determine, especially as I had already observed the very same kinds of calcareous frustules in the bodies of sundry pelagic Radiolaria which live at the surface of the ocean off the Canaries ("Myxobrachia of Lanzarote"). These strange calcareous bodies, occurring now in the form of a simple concentrically stratified disk, again resembling a shirt-button, anon assuming the shape of a sphere made up of several disks, and so on, were as likely to be secretions of the Bathybius sarcode as foreign bodies accidentally (or in the process of taking up food) introduced into the protoplasm. Of late the second hypothesis has come to appear the more probable, and biologists now hold that all these corpuscles are microscopic calcareous algæ—calcareate unicellular plants.

These investigations, confirmed as they have been by sundry other observers, seemed to show that at the bottom of the Atlantic, between the depths of 5,000 and 25,000 feet, there exists a sort of ooze which, with its other characteristics, contains a great quantity of a peculiar and as yet hardly individualized species of Moneres. The error into which we now fell consisted in over-hastily generalizing the results of these deep-sea soundings in the North Atlantic, and supposing the bed of the deep sea to be everywhere covered with similar Moneres. This inference was flatly negatived by later research. During the cruise of the Challenger, which extended over three and a half years, though careful search was made for Bathybius in the depths of various seas, it was nowhere found. We have no ground for calling in question the diligence and accuracy of the eminent naturalists attached to the famous Challenger Expedition; and all the less because its director, Sir Wyville Thomson, had been himself the first to observe the movements of the living Bathybius. Hence we must suppose that, in the portions of the deep-sea bottom explored by the Challenger, there were no Bathybius Moneres. But does it hence follow that all previous observations and inferences were incorrect?

As is very usual in such cases, exaggerated and one-sided views were at once given up, and no less exaggerated and one-sided contrary views adopted. Once it was supposed that Bathybius occurred in masses at the bottom of every sea; now its existence anywhere was denied. The Bathybius-ooze preserved in alcohol, which had been the subject of prior investigations, was now held to be nothing but a gypsum precipitate, such as is found wherever sea-water is mixed with spirits of wine. This hypothesis was first put forward by certain naturalists of the Challenger Expedition, and therefore Prof. Huxley recanted—prematurely, as I believe—his earlier views concerning

Bathybius. In *Nature* (August 19, 1875), and in the *Quarterly Journal of Microscopic Science* (1875, vol. xv., p. 392), he writes as follows:

"Prof. Wyville Thomson informs me that the best efforts of the Challenger's staff have failed to discover *Bathybius* in a fresh state, and that it is seriously suspected that the thing to which I gave that name is little more than sulphate of lime, precipitated in a flocculent state from sea-water by the strong alcohol in which the specimens of the deep-sea soundings which I examined were preserved. The strange thing is, that this inorganic precipitate is *scarcely to be distinguished from precipitated albumen*, and it resembles, perhaps, even more closely, the proligerous pellicle on the surface of a putrescent infusion (except in the absence of all moving particles), coloring irregularly, but very fully, with carmine, running into patches with defined edges, and in every way comporting itself like an organic thing. *Prof. Thomson speaks very guardedly, and does not consider the fate of* Bathybius *to be as yet absolutely decided.* But since I am mainly responsible for the mistake, if it be one, of introducing this singular substance into the list of living things, I think I shall err on the right side in attaching even greater weight than he does to the view which he suggests."

These words of Prof. Huxley's awakened marked interest, and were pretty generally thought to be the death-blow of poor Bathybius. But, in proportion as the real parents of Bathybius show a disposition to abandon their child as being beyond hope, the more do I consider it to be my duty as its godfather to defend its rights and, if possible, to restore its expiring vital spark. Here, as luck would have it, I find a valuable ally in the person of a traveled German naturalist, who quite recently observed living Bathybius off the coast of Greenland. The well-known north-polar explorer, Dr. Emil Bessels, who fortunately returned safe after the wreck of the Polaris, writes as follows of the *Haeckelina gigantea*, a giant Rhizopod, probably identical with *Astrorhiza*, previously described by Sandahl:

"During the late American North-Polar Expedition, I found in Smith Sound, at the depth of ninety-two fathoms, great masses of free, undifferentiated, homogeneous protoplasm, without any trace of coccoliths. In view of its truly Spartan simplicity, I gave to this organism (which I was able to study in the living state) the name of Protobathybius. In the report of the expedition it will be figured and described. I would simply say in this place that *these masses consisted of pure protoplasm*, in which calcareous particles occurred only by accident. They appeared to be *very sticky, mesh-like structures, with perfect amœboid movements; they took up particles of carmine, and other foreign substances, and there was active motion of the nuclei.*"—(*Jenaische Zeitschrift für Naturwissenschaft*, vol. ix., p. 277. *See* also Annual Report of the Secretary of the Navy for 1873).

In Packard's "Life-Histories of Animals" is to be seen a figure (published by Bessels) of the protoplasm-net of Protobathybius. From this figure I conclude that Protobathybius is the same as our *Bathybius*.

III. *A Critique of Bathybius.*—Having now presented to the reader the historic facts relating to Bathybius, we next address ourselves to

a *critique* of this subject. We will endeavor, by impartially weighing the facts, to form an unprejudiced judgment on Bathybius, now so decried and so generally discredited.

With respect to *dead Bathybius*—deep-sea ooze brought from the North Atlantic and preserved in spirits of wine—all the observers who have studied it closely agree in saying that it contains greater or smaller masses of coagulated protoplasm, which, in their morphological and chemico-physical properties, bear the closest resemblance to certain Moneres. The results obtained by Huxley from material examined by him—results which I myself have been able to confirm and enlarge—have been admitted as correct by all the other observers who studied the same ooze.

With respect to *living Bathybius*, we have positive testimony as to its characteristic, Rhizopod-like movements from three competent observers, namely, Sir Wyville Thomson, Prof. William Carpenter, and Dr. Emil Bessels. All three made their observations on deep-sea ooze from the North Atlantic. On the other hand, the attempts made by members of the Challenger Expedition in various seas to repeat and confirm these earlier observations on the movement phenomena led only to *negative results*.

What follows now from this testimony, all of which we must recognize as of equal credibility, but which, nevertheless, is self-conflicting? Simply that the Bathybius-ooze *has a limited geographical distribution*, and that it was an over-hasty generalization to people all deep-sea abysses with that organism. But from the fact that the Challenger Expedition did not rediscover living Bathybius it surely does not follow that the observations made *in other localities* by the Porcupine Expedition were faulty. Or, from the fact that the Challenger Expedition found Radiolarian ooze only in a comparatively limited area in the Pacific and nowhere else, must we draw the conclusion that no such thing exists? We know that the vast majority of organic species have a limited distribution; why, then, should not the distribution of Bathybius be limited too?

Hence I confess I cannot understand why Huxley should have so suddenly and so totally changed his views about Bathybius. Still less do I understand how, at the last meeting of the German Naturalists' Association at Hamburg (September, 1876), Bathybius could ever have been publicly interred. In the Berlin *Nationalzeitung* I find the following notable report (dated Hamburg, September 21st) of a paper by Prof. Möbius, on "Marine Fauna and the Challenger Expedition:"

"Over these plateaus [deep-sea plateaus, from 3,700 to 4,000 feet deep] we should look for the mysterious 'primordial slime,' Bathybius, to which the famous Huxley gave the name of *Bathybius Haeckelii* as a compliment to his genial friend of Jena. But, unfortunately, natural history met with a sad mishap. Bathybius, which fitted so nicely into the modern hypotheses of the be-

ginning of things, turned out to be an artificial product of gypsum precipitated by alcohol from sea-water, in which it is held in the state of solution. Wherever fresh specimens of the ooze have been examined on shipboard, no traces of 'Bathybius' have been found. The audience were fairly startled when Prof. Möbius, by simply mixing alcohol with a glass of sea-water, caused Bathybius to appear before their eyes."

Verily, this is a remarkable kind of logic. Because spirits of wine mixed with sea-water precipitates gypsum, therefore Bathybius-ooze kept in spirits of wine is precipitated gypsum! And this demonstration "fairly startled" the members of a German Association of Naturalists! That strong spirits of wine mixed with sea-water produces a light, flocculent gypsum precipitate is known to every one that has preserved marine animals in spirits of wine. But so, too, is it known to every man who, like Huxley and myself, has closely examined the Bathybius-ooze collected by the Porcupine Expedition, that the Moneres-like, albuminous bodies found therein consist actually *of albuminous substance and not of gypsum.* Carmine stains them red, nitric acid and iodine yellow; sulphuric acid decomposes them, and they give all the other reactions of *protoplasm*, which is not the case with gypsum, as every one knows.

If we finely pulverize certain kinds of chalk, or chalky marl, we obtain a fine white flour, that might easily be mistaken for the remarkable Radiolarian ooze found by the Challenger Expedition in a limited area of the Pacific (and there only), at a depths ranging from 12,000 to 26,000 feet. This Radiolarian ooze, which I am at present engaged in studying, consists almost exclusively of the most beautiful and varied forms of siliceous Radiolarian shells. But with the naked eye we cannot distinguish this dried ooze—a wonderful microscopic museum of Radiolaria—from pulverized chalk-marl containing not a single Radiolarian shell. I now propose that at their meeting in Munich next September (1877) the Naturalists' Association experimentally demonstrate that these enormous Radiolarian deposits, discovered by the Challenger Expedition at the bottom of the Pacific, have no real existence. "The experiment is a very simple one." Let the lecturer bray in a mortar, in sight of the assembled naturalists, a bit of chalk-marl containing no Radiolaria. The white powder so obtained does not contain a single Radiolarian; therefore the Pacific ooze (consisting exclusively of Radiolarians) does not exist, since these two substances cannot be distinguished from each other by the naked eye—*quod erat demonstrandum.* We are confident that this striking experiment will "fairly startle" the beholders, and make an end of Radiolarian ooze.

IV. *A Critique of the Moneres.*—From the foregoing, we think it clearly appears that *the non-existence of Bathybius is not proved.* Nay, it is highly probable that the observations of Wyville Thomson and Carpenter and Bessels on the movements of living Bathybius

were correct. We will, however, for the nonce, suppose the contrary to be the fact, and will grant that Bathybius is not a Moneres, nor even an organism. Does it follow from this that the Moneres too have no existence? Or must we say that, as the familiar great sea-serpent of fable does not exist, therefore there is no such thing as a sea-serpent? We know that there are many sea-serpents belonging to the family of the viviparous and highly-venomous *Hydrophidæ* (*Hydrophis*, *Platurus*, *Æpysurus*, etc.), which chiefly inhabits the Indian Ocean and the Sunda Archipelago, but none of which attain any considerable size.

It were useless here again to quote my own researches which have demonstrated the existence of upward of a dozen different species of Moneres, some living in fresh, others in salt water. I would, however, state that these observations have since been repeated and confirmed by a number of competent investigators. Some of these Moneres appear to be very widely distributed in fresh water, as for instance the genera Protamœba and Vampyrella. *Protamœba agilis* and *Vampyrella spirogyræ* may be observed almost any summer at Jena. *P. primitiva* and *V. voraæ* have been seen by sundry observers in very diverse localities. Other new Moneres forms have been quite recently discovered by Cienkowski and Oskar Grimm. When the attention of microscopists has been more generally directed to these extremely simple organisms, we may hope that our knowledge of them will be considerably widened and deepened.

Whether Bathybius is or is not a true Moneres, at all events we already know with certitude a number of *true Moneres* whose fundamental importance is quite independent of Bathybius. We know that even now there exist in the waters of our planet a number of very low forms of life, which are not only the simplest of all actually observed organisms, but even the *simplest imaginable* of living things. Their whole body, in the fully-developed and reproductive condition, consists of nothing but a little mass of structureless protoplasm, whose changing, variable processes all at once discharge the various life-functions—movement, sensation, transmutation of matter, nutrition, growth, and reproduction. Morphologically considered, the body of a Moneres is as simple as an inorganic crystal. We cannot distinguish in it separate parts; or, rather, each part is equivalent to each other. These facts and their far-reaching consequences apply to *all Moneres* without exception—with or without Bathybius!—and hence it does not affect the theory at all whether Bathybius exists or not.

When we describe these Moneres as "absolutely simple organisms," we of course only express their *morphological simplicity*, the absence of distinct organs. Chemico-physically, they may be highly composite; indeed, we must in any case ascribe to them, as to all albuminous bodies, *a highly-complex molecular structure*. Many regard the slime-like albuminous body of Moneres as a single chemical albu-

men combination, while others see in it a multitude of such combinations; others, again, regard it as an emulsion or intimate blending of albuminous and fatty particles. For a general biological view of the Moneres this is of subordinate interest; for, however the case may be, the creature is at all events, *from the anatomical point of view*, perfectly simple—an organism without organs. It proves incontrovertibly that life does not depend on the coöperation of different organs, but on a certain chemico-physical constitution of amorphous matter—on that albuminous substance which we call sarcode or protoplasm—a nitro-carbon compound in the semi-fluid state.

Hence, life is not a result of organization, but *vice versa*. Amorphous protoplasm gives rise to organized forms. Having already, in previous writings, called attention to the high importance of the Moneres from this and other points of view, I can here only refer to those papers. At present I must content myself with pointing out the importance of the Moneres in connection with the great question of the origin of life. The oldest organisms, sprung by spontaneous generation (Urzeugung) from inorganic matter, must have been Moneres.

It is precisely the general importance of the Moneres for the solution of the greatest of biological problems that makes them a stumbling-block and a scandal to the opponents of the doctrine of evolution. These men, of course, take every opportunity to dispute the existence of Moneres, exactly as was done in the case of *Eozoön Canadense*, the much-disputed oldest fossil of the Laurentian formation. The most experienced and competent students of the class Rhizopoda—at their head Prof. Carpenter, of London, and the distinguished anatomist Max Schultze, of Bonn, deceased—are firmly convinced that the American Eozoön is a genuine Rhizopod—a Polythalamium, near akin to Polytrema. I have myself for several years made a special study of Rhizopods. I have minutely examined several fine preparations of Eozoön made by Carpenter and Schultze, and I have not the slightest doubt that it is a genuine Polythalamium, and not a mineral.

But, just because of the extraordinary fundamental importance of Eozoön, and because the discovery of that fossil adds several millions of years to the earth's organic history, making the primitive Silurian formations to appear recent by comparison, and rendering a great service to the doctrine of evolution, therefore it is that the opponents of that doctrine so stoutly affirm that it is not of organic origin at all, but purely mineral. But as the high importance of Eozoön was placed in its proper light by these unavailing attacks of ill-informed opponents, so is it, too, with the Moneres—with or without Bathybius. The true Moneres remain, forming an immovable foundation-stone of the doctrine of evolution.—*Kosmos.*

MOLECULAR MAGNITUDES.

By L. R. CURTISS.

IN entering upon an analysis of the subject of atomic and molecular magnitudes, it is desirable that we should have as clear an idea of the immeasurably small in Nature as possible. To the astronomer the size and relative distances of the celestial bodies are real magnitudes, and so also, to the molecular physicist, the magnitudes verging upon the infinitely small are just as much of a reality. The billionth part of an inch is just as much of a fact as a billion miles.

The mathematical definition of a point consists in stating it as a locality without length, breadth, or thickness; but we receive no very concise idea of the definition until we proceed graphically, and make a dot with a pencil or otherwise, which shall possess limited dimensions of length and breadth; then, by the metaphysical process of abstraction, we dispense with the linear dimensions of length and breadth, and thus purify our conceptions concerning physical magnitudes, and place ourselves in a way of realizing the entity or real existence of the invisibly small in Nature.

In the animal kingdom are found myriads of forms so minute that their bulk is reckoned by less than the millionth part of a cubic inch, yet each one is endowed with organs of sense or assimilation sufficient to serve the purpose in their sphere of life. The vegetable kingdom, also, offers abundant specimens of microscopic forms, calculated to excite our admiration by the beauty and minuteness of their organisms. Such is notably the case in several forms of *Diatomaceæ*. The striated markings of *Pleurosigma fasciola* aggregate to 64,000 to the inch, while *Amphipleura pellucida* often exhibit striæ exceeding 100,000 to the lineal inch. And yet the skeletons of these minute organisms are composed mainly of silex, the silex again being made up of silicon and oxygen. Notwithstanding the almost infinitesimal magnitudes of the organic world, human skill is able to compete in the matter of minuteness. Platinum wire has been drawn so fine as to rival in minuteness the smallest fibre of the spider's web. Gold has been deposited upon the surface of other metals, and drawn to such extreme thinness that a thousand-millionth part of a grain exhibited the visible characteristics of the metal. The oscillations of the horizontal pendulum can be measured to the $\frac{1}{50,000,000}$ part of an inch, by the aid of a small mirror, a beam of light, and a graduated scale for reading the vibrations. Nobert, with a mechanical skill unsurpassed, has repeatedly ruled with a diamond-point upon glass the nineteenth band of his test-plate, consisting of lines less than the $\frac{1}{111,000}$ of an inch apart, and it is claimed that he has succeeded in

ruling plates covering 224,000 lines per inch, such as would aggregate in superficial areas to over 50,000,000,000 to the square inch! Such minute divisions are wholly beyond the resolving power of the most elaborate of modern microscopic appliances; for it has been shown by Sorby [1] that the ultimate power of the microscope for distinct definition is limited to the examination of magnitudes not less than one-half of the average wave-length of the luminous spectrum; and it is shown, upon the authority of Helmholtz, that when the amplitude of the object is less than this half wave-length—or somewhat in excess of 80,000 to the inch—the dark interference-fringes impair the definition of the instrument, except in the case of striated markings, which may be clearly defined, or resolved, by so arranging the illumination as to mask the fringes, and bring out a good definition even in excess of 100,000 to the inch. Hence, the main difficulty attending the possible amplification of objects less than about the $\frac{1}{100000}$ of an inch in diameter is a purely physical one, and depends upon the constitution of light itself.

The various phenomena of chemical physics teach us that matter is not homogeneous, but is made up of infinitesimal particles or atoms, the term *atom* meaning *indivisible particle;* and that the term *molecule*—meaning literally *a little mass*—refers to an aggregation of two or more atoms. Thus, a crystal of common salt may be pulverized until one of its fragments is barely discernible to the highest range of microscopic power, and still this fragment will retain all the characteristics of salt. This same microscopic portion is susceptible of a further subdivision by solution in water, when the spectroscope will detect its presence in the still minuter quantity of the one-hundred-millionth part of a grain. Here, in the case of salt, physical analysis ends, and, aside from chemical analysis, any further subdivision must be by the process of abstraction, until by its means we arrive at the mental conception of a portion so minute as to consist of an atom of sodium united by the bonds of chemical affinity to an atom of chlorine. This is now a molecule of common salt. Any further division destroys the entity of the compound, and results in the decomposition of the salt into the atoms of its elements. Hence a simple molecule is the smallest portion of any chemical compound that is not susceptible of subdivision without destroying its entity, or, in other words, the smallest number of atoms that can cohere to form a compound constitute the molecule of that compound. An atom is designated as the ultimate particle of any elementary body, and is not susceptible of any further division within the range of human analysis.

Were it possible to magnify the atoms of matter to a diameter available for distinct vision, we should be met at the outset by a difficulty too astounding for realization. It is a matter of easy proof

[1] H. C. Sorby, F. R. S., in his anniversary address to the Royal Microscopical Society, in the *Quarterly Journal of Microscopical Science* for April, 1876.

that the magnifying of any object while in motion will exhibit that motion increased in velocity just as many times as the diameter of the object is augmented. Suppose we had at our command an instrument competent to amplify the atoms to the one-fiftieth of an inch in diameter: in the case of the hydrogen-atom the necessary magnifying power would be 10,000,000 diameters, under which power the atoms would have their motions enhanced by the same multiple, and we should then be called upon to examine an image the fiftieth part of an inch in diameter plunging across the field of vision five hundred million times faster than the flight of a cannon-ball.

It follows, since human skill is incompetent to penetrate by any mechanical means into the internal structure of matter, that we shall be compelled to direct our labors to other modes of investigation if we would know more of the atomic structure of matter, possessing as it does a minuteness far surpassing the analytical power of the microscope; in fact, so hopelessly ultra-microscopic as to elude all other processes except that of mathematics and experimental investigation.

The question of the infinitely large and the immeasurably small has engaged the attention of philosophers since the days of Democritus. Modern investigators are, however, in possession of experimental data that aid them in arriving at facts with ever-increasing accuracy. We have the atomic theory first placed upon a substantial basis by Dalton, which treats of the atomic constituents of matter, and gives to each atom a definite size and weight, and establishes the proposition that atoms combine to form molecules, and that molecules aggregate to masses. We have also the kinetic theory of gases, which has been placed upon a purely mathematico-scientific footing, as has also the department of hydro-kinetics; and experiments within these departments are accumulating evidence concerning the atomic and physical structure of matter.

The kinetic theories are based upon the conception that these particles or atoms are in constant motion among themselves; and it assumes, also, that their movements have an infinite series of velocities in all conceivable directions, but with varying degrees of intensity. This idea of atomic and molecular motion puts us in possession of an important factor for determining the causation of all physical phenomena. Of course we do not presume to say that the atom is the primordial or ultimate constituent of matter, for there are many evidences to show that the present list of sixty-five elements of matter may not be elementary at all, but isomeric compounds of one or more simpler constituents.

The question might here be asked, "How does the physicist know anything of the relative size of atoms and their vibratory motions?" The answer is: by mathematical deductions, based upon the behavior of gases; by experimental evidence, principally in the domain of radiant heat; also in the interdiffusion of liquids and gases. Researches

in these departments have determined, with a great deal of certainty, that the atoms and molecules of matter do not touch each other, and that the various velocities they may assume under different conditions are the causes of all the phenomena of light and heat. And, moreover, it has been determined by the most refined experiments, with special instruments of precision, that these atoms have a definite size and weight, and, under special conditions, a definite velocity and momentum. The pressure of gases has also been defined as the resultant of the molecular bombardment or impact of these flying projectiles against the sides of the containing vessel.

Some molecular data have been tabulated from the calculations of Clausius, Maxwell, Thomson, and others, but the figures given are wholly beyond human comprehension. Thus the number of atoms in one cubic inch of hydrogen-gas, at the temperature of freezing water and under the pressure of one atmosphere, is given in the neighborhood of three hundred millions of millions of millions, each atom possessing an initial velocity of over a mile per second, covering nearly eighteen billions of oscillations in different directions in the same second of time. That is to say, each particle of hydrogen, while moving at the rate of seventy miles per minute, has its course wholly changed something like 17,700,000,000 times in every second. Sir William Thomson concludes, from the data given by Clausius, that the diameter of the gaseous molecule is somewhere between the $\frac{1}{2500000000}$ and the $\frac{1}{5000000000}$ of an inch, and as the density of known liquids and solids is from 500 to 16,000 times that of common air, he concludes that the distance from centre to centre of contiguous molecules in solids is less than the $\frac{1}{2500000000}$ and greater than the $\frac{1}{5000000000}$ of an inch; and he illustrates by supposing "a drop of water to be magnified up to the size of the earth, each molecule to be amplified in the same proportion, these molecules will then be less in size than cricket-balls, but larger than small lead-shot."

Imagine the particles of the air we breathe flying about at the rate of eighteen miles per minute—a velocity exceeding that of a cannon-ball—a velocity which, if the particles were all moving in one direction, would constitute a tornado ten times more violent than any terrestrial hurricane! How is it, then, that we can survive the incessant bombardment of such a storm of projectiles? Simply because the particles are moving in all directions, so as nearly to counterbalance each other's momentum. Were it not that the molecules are continually changing their direction by executing a sort of carrom upon their neighbors, the interdiffusion of liquids and gases would be almost instantaneous. If the molecules could project in straight lines without interference with each other, the opening of a bottle of perfumery would permit the diffusion of its odor to the distance of many hundred feet sooner than you could open and recork the bottle, or, in some instances, about one-third of a mile in one second of time.

An instructive experiment may be made: First, finely pulverize indigo, charcoal, or carmine, and then mix either of them with water, and place under the microscope, when an incessant movement of the small granular particles will become apparent; and the smaller the particles, the more rapid and uniform will be their movements. These movements are chiefly of a vibratory kind; and it is when the particles are minutely divided, so as to approach the limits of microscopic range, that this vibratory motion, together with an irregular axial rotation, approaches a degree of perfection that is beautiful as well as suggestive. This experiment is well calculated to assist us in forming a mental conception of the magnitudes and the motions of those atoms and molecules which have for their realm the regions below and beyond the immeasurably small.

As to the shape and internal structure of atoms, there is no definite knowledge; but Helmholtz's studies of certain equations in hydro-kinetics, several years ago, gave rise to the idea that vortex-motion in a frictionless medium would exist forever—an assumption which is purely hypothetical; but since the proposition has been enlarged upon by Sir William Thomson—who conjectures that the atoms might be filaments or rings endowed with a vortex-motion—the subject assumes a shape better calculated to form the basis of a scientific theory. To be sure, mathematical formulas might show that the behavior of a vortex-filament in a non-resisting medium would answer to that ascribed to atoms—indestructible and unalterable through all time; still, at the same time, the means at hand for its complete mathematical verification are not adequate to place the subject beyond the regions of theory. Prof. Tait, in a review of this subject in his "Recent Advances of the Physical Sciences," remarks that, "with a little further development, it may be said to have passed its first trial, and, being admitted as a possibility, may be left to time and the mathematicians to settle whether it will really account for everything experimentally found."

Small as these atoms are, we are not permitted to stop here, but remember that there is a finer medium environing them all, embracing possibly a complexity of internal structure sufficient to baffle human investigation for all time. This cosmic or luminiferous ether is supposed to fill all space, intermolecular and interstellar, and to be the medium in which the atoms and molecules move like motes in the sunbeam.

Atoms and molecules may vibrate to and fro, or may execute various oscillations about each other, with a moderate velocity, or perform their motions with a rapidity beyond conception; and be the intensity of the vibrations ever so great or ever so small, these same vibrations determine the amplitude of the ethereal waves—those waves of greatest length giving rise to all the phenomena of radiant heat, while shorter ones constitute light in all its luminous and chromatic effects; as also

the ethereal waves of still more rapid undulations and lesser length furnish the actinic force of light. And if the mathematical deductions of such as Maxwell and Boltzmann, together with the refined researches of many others in this border-land of science, are not at fault, we would not be surprised if, at some early day, the solution of the phenomena of electricity should be found in some way connected with ethereal vibrations, infinitely more rapid and minute than those which produce the actinism of the ultra-violet spectrum. The difficulties attending the solution of this problem may be more fully comprehended when we recollect that, in dealing with vibrations more rapid than those bordering the visible spectrum, we are leaving regions where the undulations comprise nearly one thousand million of millions in a second of time, only to be confronted with others of infinitely greater rapidity.

These ethereal and molecular actions are going on eternally about us. The photographer's sensitized plate may receive an image that maps out the constellations, or, through the prism of the spectroscope in lines of light, we may read of the constituents of the nebulæ, and thus upon the waves of ether do we hold communion across the universe by that ethereal chain of motion which binds us to the stars!

SIMPLE EXPERIMENTS IN OPTICS.

By ELIZA A. YOUMANS.

THE little work of Mayer and Barnard, designed to introduce beginners to the experimental study of optics, is so much needed, so skillfully done, and may be so helpful to teachers and students of all ages, that it is desirable to offer a few illustrations of the method of experiment adopted, and to point out some of the cheap and simple ways which Prof. Mayer has hit upon for exemplifying and proving optical phenomena. We shall make free use of his text as well as his cuts in the present article. Fig. 1, for example, represents the arrangement adopted to prove that light moves in straight lines. He first gets three little blocks, two or three inches square; then three slips of pine, three inches by four and one-eighth of an inch thick; and then three postal-cards, through which a small aperture is to be made. The authors say: "Just here we need a tool for making small holes and doing other work in these experiments; and we push, with a pair of pliers, a cambric needle into the end of a wooden pen-holder or other slender stick, putting the eye-end into the wood, and thus making a needle-pointed awl." This is an excellent little contrivance, and we suggest to the pupil to make a set of them with different-sized needles, which he will find very useful. Now, lay the postal-

cards flat on a board, one over the other; measure off a half-inch from one end of the top postal-card, and with the awl punch a hole through them all just half-way from each side. Trim the holes with a penknife, and then take one of the cards and one of the wooden slips and put the card squarely on one of the wooden blocks, and, placing the slip over it, tack them both down to the block. Place one of the blocks near a lighted lamp, as shown in the figure, and another at the

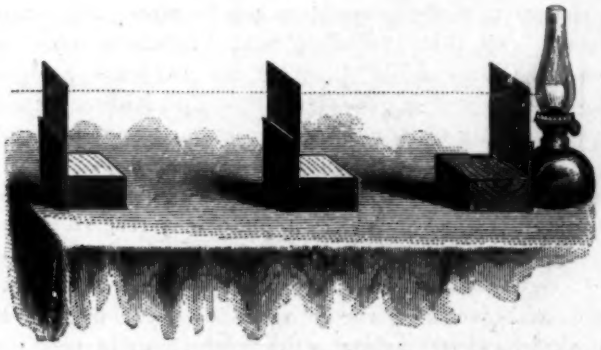

FIG. 1.—EXPERIMENT PROVING THAT LIGHT MOVES IN STRAIGHT LINES.

opposite side of the table, where the observer can sit to look through the aperture. When the light is seen through both openings, draw the third card into line between the others, when the ray will be seen to pass through all three cards. Next, take a piece of thread and stretch it against the sides of the three cards as they stand, and it will be seen that they are exactly in line, and, as the holes in the cards are at the same distance from their edges, it is proved that the beam of light that passes through all the holes must also be straight. If the position of the blocks is changed, so that the directions of the holes in the cards are different, the same effect will be observed, so that it is demonstrated that light moves in exactly straight lines in all directions from the source of illumination. Of course, a pupil can learn from a book that light moves in straight lines, but this will be a matter of hearsay or authority, and not of direct knowledge, while if he makes this experiment he will have begun to prove things for himself, and the preparation for it, and trial in different ways, will be a good exercise in manipulation.

Now, if the student wishes to prove the variation in the quantity or intensity of light at varying distances, he can do it in the simple way shown in Fig. 2. A small slit is cut in the card near the lamp, through which the light passes. A sheet of white paper, resting against some books at the opposite side of the table, forms a screen, upon which the light falls. A bit of paper, an inch square, is held by the point of the awl, the handle of which is stuck in some

wax on the table. Set the needle-awl, with the bit of paper, about twelve inches from the lamp, and then darken the room. Upon the screen, which is placed two feet from the lamp, will then be seen the shadow of the square bit of paper. With a lead-pencil trace an outline of this shadow on the screen, and then move it a foot farther back; and note how much the shadow is increased in size. With the pencil trace this shadow on the screen, and then laying the paper

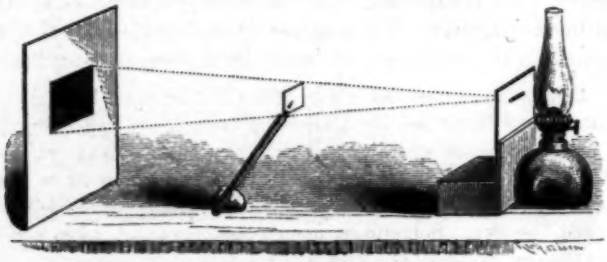

FIG. 2.—EXPERIMENT WITH SHADOWS.

on the table and measuring the two shadows, you will see how they compare in size, and get a clew to the principle of inverse squares, as it is called.

Fig. 3 represents the means used in showing that the angle of the ray as it strikes the mirror is the same as that at which it is reflected. *A* and *B* are two of the postal-cards and their blocks used in the first experiment, turned with their inside faces toward each other, and separated by three more blocks of the same dimensions as those sup-

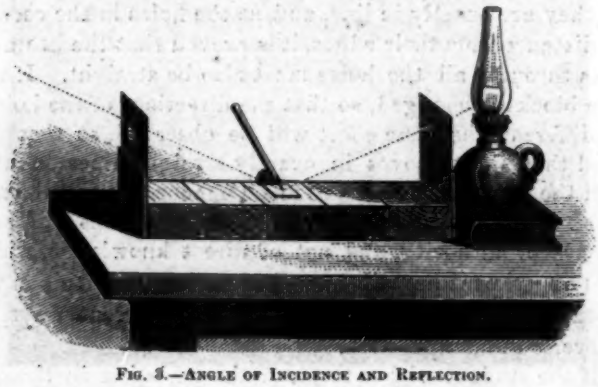

FIG. 3.—ANGLE OF INCIDENCE AND REFLECTION.

porting the cards. The flame is placed even with the hole. On the middle block rests a piece of glass, coated on the bottom side with black varnish. The eye looks through the hole *B* upon the glass, where it sees a small spot of light that is the reflection of the ray from the lamp through the hole *A*. The point of the needle is placed

directly over this spot, and held in position by the wooden handle with a piece of wax. A strip of paper, filling the distance from *A* to *B*, and four inches wide, is held upright between the cards, with the bottom resting on the mirror. The edge of this is marked with a pencil at the hole *A*, and again at the needle-point. A straight line joining these marks will form an angle at the bottom of the paper that is identical with the angle of incidence. By reversing the ends of the paper, and comparing this line with one from *B* to the needle, both will be found alike. The angles of incidence and reflection agree.

In regard to the reflection of light, Prof. Mayer remarks:

"The clouds, the water, the grass, rocks, the ground, buildings, the walls inside, clothing and furniture, and everything we can see, reflect light in every direction again and again, and thus it is that all spaces, without and within, are filled with light so long as the sun shines. At night the sun sinks out of sight, and still it is light for some time after, for the sunlight is reflected from the sunset-clouds and the sky. Sometimes, upon a summer's day, when broken clouds partly hide the sun; you will see long bars of dusky light streaming from openings in the clouds. These long bars are beams of sunlight shining upon dust and fine mist floating in the air, and we see them because each speck and particle reflects light in every direction."

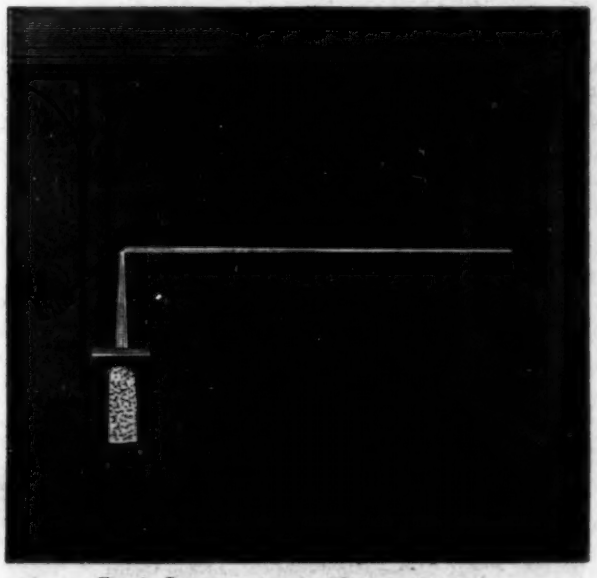

FIG. 4.—LIGHT REFLECTED BY FLOATING PARTICLES.

Fig. 4 shows the effect of particles in scattering the light. A clean glass jar stands upon a black cloth laid on a table in a dark room, and over its mouth rests a postal-card having a slit in it one inch long and one twenty-fifth of an inch wide. A beam of light enters the room from one side, and is thrown downward upon the postal-card by a

hand-mirror. Now set fire to a small bit of paper, and drop it into the jar. When it is burned out, put the postal-card in place, and the vessel will be filled with smoke. The beam that is reflected downward from the mirror enters the slit, and you see a slender ribbon of light extending downward through the jar, while all around it is quite dark and black. Fig. 4 shows the light streaming through the opening in the card, and lighting up the particles of smoke in its path. Take off the card, and let the reflected beam fall freely into the jar: the smoke is now wholly illuminated, and the vessel appears to be full of light

To make a milk-and-water lamp:

"Take away the jar and put a clean glass tumbler in its place. Fill this with water and throw the beam of reflected light down upon it, and the water will be lighted up so that we can easily see the tumbler in the dark. Now add a teaspoonful of milk to the water and stir them together. Throw the beam of light down once more. This is indeed remarkable. The tumbler of milk-and-water shines like a lamp, and lights up the room so that we can easily see to read by its strange white light. Move the mirror and turn aside the beam of light, and instantly the room becomes dark. Turn the light back again, and once more the glass is full of light. Here the minute particles of milk floating in the water catch and reflect the light in every direction, so that the entire goblet seems filled with it, and the room is lighted up by the strange reflections that shine through the glass."

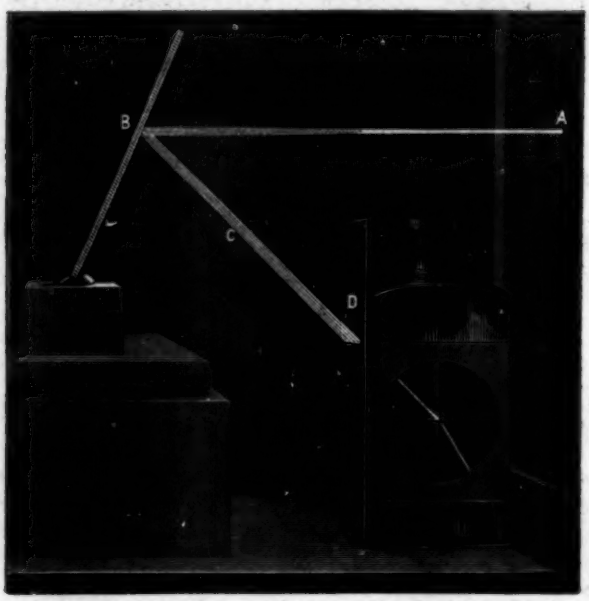

FIG. 5.—EXPERIMENT SHOWING THE LAW OF REFRACTION.

By the following simple contrivance, illustrated in Fig. 5, Dr. Mayer shows the pupil how he can demonstrate the law of the refraction of

light: 1. We have a clear glass bottle, with a sheet of white paper, in which a perfectly round hole has been cut, pasted on its side; 2. Horizontal and perpendicular lines are drawn with ink upon the glass at right angles across each other, and within this circle, dividing it into four equal parts; 3. Water is poured into the bottle until its level is that of the horizontal line; 4. A postal-card containing a slit is placed as at *D* in the figure; 5. The mirror, *B*, reflects the beam into the bottle so that it may touch the water where the two lines cross. The light is seen to bend as soon as it enters the water. The index of refraction for all liquids may be determined by measuring the distance from where the beam enters to the perpendicular, then the distance from the perpendicular to where it vanishes, and dividing these into each other. The constancy of the quotient for each particular liquid can also be shown by having the beam strike the water at various angles, making these measurements and dividing. No matter how the distances vary from the perpendicular, when divided into each other they give the same result for the same liquid.

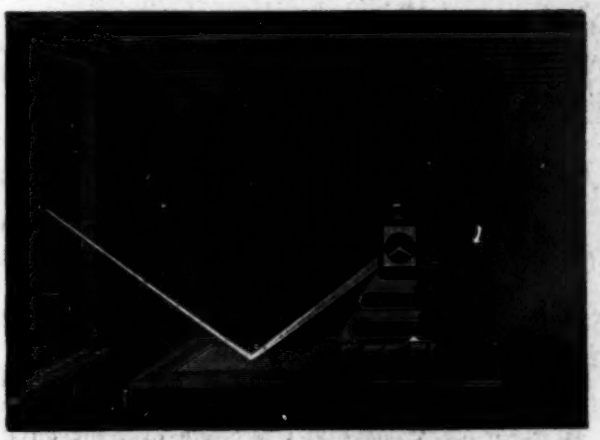

FIG. 6.—TOTAL REFLECTION.

With a mirror on the table and our bottle arranged as in Fig. 6, total reflection will occur, that is, all the light of the beam will be thrown downward from the surface of the water.

"Sometimes, when walking along a road on a warm day, you may observe a curious quivering in the air just where the road seems to meet the sky, as it goes over a hill. The objects near this point appear to be distorted and to tremble, or they assume fantastic shapes. Here we have an instance of refraction caused by the heated air just above the surface of the road. The light passing through these layers of unequally-heated air is refracted unequally, and the objects that reflect the light appear distorted. In some instances the refraction may pass the critical angle, and we may see the objects apparently doubled by reflection. Warm, calm days by the sea show the same thing, when distant

vessels appear repeated in the sky, or when distant land that is really below the horizon 'looms' up and glimmers upon the horizon in trembling headlands. This illusion is called the mirage, and takes place when refraction exceeds the critical angle and becomes reflection.

"Fill a clear glass tumbler with water, and put a spoon in it, or dip one finger in the water, and hold it above your head, so that you can look into the water from below. You will find that you cannot see through the water up into the air above. The under-surface of the water will appear to shine like burnished silver, and the spoon or your finger will be reflected in it, as in a beautiful mirror. This illustrates total reflection, and shows that in this case all light thrown upward through the water is reflected from its surface. Look into the tumbler from above, and it appears full of clear water. Look into it from below, and it seems as if an opaque sheet of silver rested on the water, and shut out the view of everything above."

Fig. 7 shows a neat and simple arrangement by which water can be used for a lens to illustrate refraction. It is merely a long pine box fourteen inches high, made of thin boards, with one side open, and a round hole in the top five inches in diameter. On this opening rests a hemispherical glass dish made by cutting off the round top of a glass shade, and which is filled with clear water. A piece of looking-glass is supported below at an angle of forty-five degrees, so as to reflect a stream of sunlight upward through the water-lens. The rays are thus refracted and brought to a point at a proper distance above. If a sheet of paper is held horizontally just over the bowl, it will be lighted up by the rays coming through the lens. Raise the paper slowly, and the circle of light on its surface will grow smaller and brighter, till it is reduced to a point, when it will burn a hole in the paper. If a little smoke is diffused through the space, it will reveal the double cone of light, with one base upon the surface of the water-lens, and the other forming a large circle of light upon the ceiling, the rays all crossing at the focal point. With some additional attachments Prof. Mayer makes such a lens work in a magic lantern for projecting large pictures upon screens, the whole mechanism being estimated to cost but $3.20.

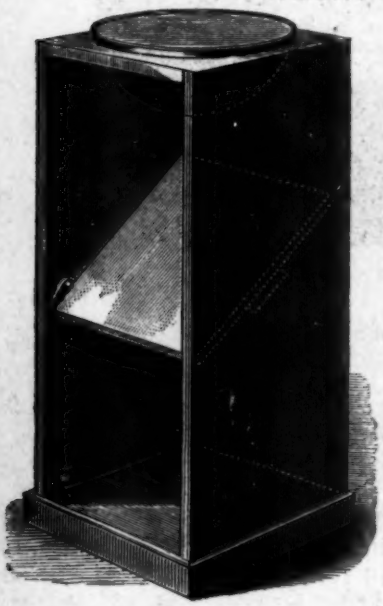

FIG. 7.—THE WATER-LENS.

One of the most beautiful experiments in total reflection is that illustrated by Fig. 8. A Florence flask filled with water acts as a

lens. The room is darkened, and the light coming from without is brought to a focus on the inside of the flask. A hole has been made through the glass, and as the water streams out the light is totally

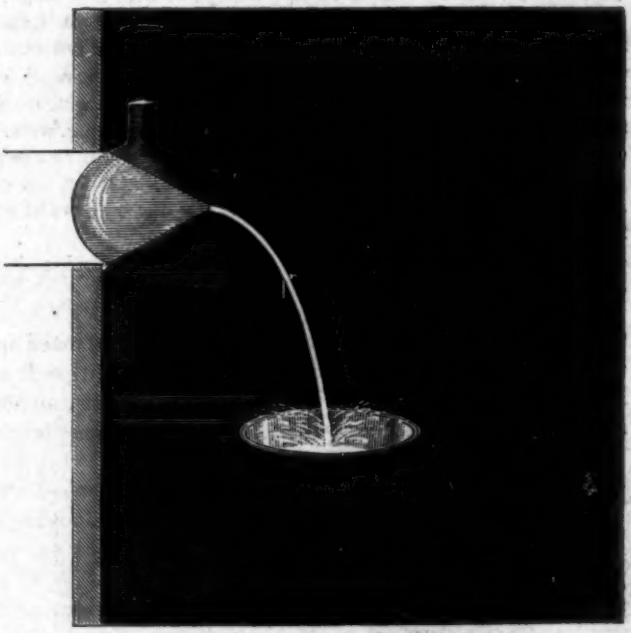

FIG. 8.—THE FOUNTAIN OF FIRE.

reflected so as to illuminate the stream as it falls into the pail below. Of this experiment the authors say:

"How magical! The curving stream of water is full of light, and appears like a stream of molten iron. The spot where it falls seems touched with fire. Put your finger in the stream of water, and it is brightly illuminated. Of course, the water soon runs down, and the display stops. To prevent this, bring water in a rubber tube from the water-pipes in the house, and then regulate the supply so that the receiver may be kept full as fast as the water runs out.

"Place a piece of red glass behind the flask in the beam of sunlight, and the stream of water will look like blood. Touch it, and the hand will be crimson, and the scattered drops that fall in a shower into the tub will shine like drops of red fire. Place a green or blue glass behind the flask, and the stream of water will turn green or blue, and present a most singular appearance. Hold a goblet in the stream, and it will overflow with liquid light. Flashes and sparkles of fire will appear in it, and foam over the sides, shining with brilliant light.

"This beautiful experiment is as interesting as it is strange and magical, and it illustrates both refraction and total reflection. The flask makes a lens, and the falling stream of water is lighted up by the cone of light that enters it at the hole in the flask. Both the water and the light pass out of the hole together,

the light inside of the water. That this is so, may be proved by permitting the water to escape, when the light will be seen shining out of the hole horizontally into the room. Why, then, does it not shine out into the room while the water is escaping? When the stream of water is flowing out, it falls in a curve into the tub on the floor. The beam of light, passing out with the water, meets its curved surface at such an angle that it is totally reflected. This beam of reflection again meets the surface of the water, and is again totally reflected. In this manner it is reflected from side to side, again and again, till it reaches the tub, and there we see it shining brightly. It is a prisoner in the water, and follows it down into the tub. When you put your hand in the falling water, you see that it is lighted brightly, and yet the stream by comparison is rather dark. If it were pure distilled water it would hardly be visible. As it is full of floating specks and motes, each of these reflects light, and these cause the water to appear full of light.

"This fountain of fire is a charming experiment for a school, and its double lesson makes it as interesting as it is beautiful."

Prof. Mayer uses his flask-and-water lens, as illustrated in Fig. 9, to get a solar microscope, and so well does it succeed that it is doubtful if it can ever be excelled for combined cheapness and efficiency. With some blocks of wood, a twenty-five-cent microscopic glass lens,

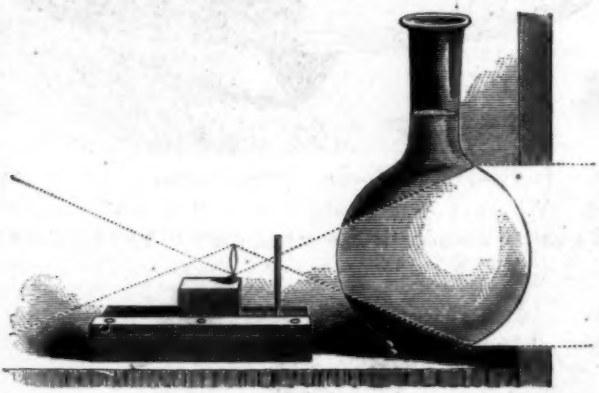

FIG. 9.—THE SOLAR MICROSCOPE.

and a slide carrying a microscopic object, he gets very striking effects. Animalcules in water, and all sorts of transparent microscopic objects, can be projected upon a curtain by its aid, so that a large number of people can be entertained by observing the effects produced.

Fig. 10 shows how a common iron top, such as may be found in any toy-store, may be transmuted into a color-top. The shape of the handle is of no importance. By fastening disks of various colors, made of drawing-paper, around it, all sorts of chromatic changes may be studied. With red, green, and violet, white will appear by spinning the top. With one-quarter green and three-quarters red a deep

orange may be produced. Directions are given for using the top on the lantern, and casting the colors on the screen, so that a great many persons may see it at once.

FIG. 10.—THE COLOR-TOP.

Another method of producing these recompositions is illustrated in Fig. 11. We have here a square piece of board for a base, an upright block at the corner, two pieces of glass to which the dotted lines

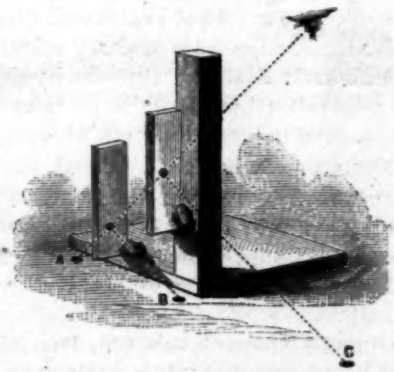

FIG. 11.—DIRECT RECOMPOSITION OF THE COLORS.

run, and in which reflections are to be seen at the spots where the lines meet, and three pieces of paper at *A*, *B*, and *C*, painted respectively red, green, and violet. The image of *A* is supposed to go through

both pieces of glass to the eye, while the reflected images of *B* and *C* are, by adjustment, to be made to overlap each other and the image of *A*. When this is accomplished a single white object is seen. This experiment is conducted most successfully near a window, and with the back toward the light. When the red and green images are superimposed a yellow one is seen, and when the green and violet are superimposed we have blue. The colors originally supposed to be primary were red, yellow, and blue. Prof. Mayer has here given a simple means of refuting this old theory.

Prof. Mayer describes the construction of a cheap and simple heliostat for directing the sunlight into the room, and keeping the beam in the same position for all these experiments. We refer the reader to the book for the details of its construction, and the full-page woodcuts by which it is illustrated. A great point has been gained for scientific education by thus putting it in the power of any student, with ordinary ingenuity, a few tools, and a few shillings, to make such a large number of interesting and instructive experiments.

ON ELEMENTARY INSTRUCTION IN PHYSIOLOGY.

By T. H. HUXLEY, F. R. S.

THE chief ground upon which I venture to recommend that the teaching of elementary physiology should form an essential part of any organized course of instruction in matters pertaining to domestic economy, is that a knowledge of even the elements of this subject supplies those conceptions of the constitution and mode of action of the living body, and of the nature of health and disease, which prepare the mind to receive instruction from sanitary science.

It is, I think, eminently desirable that the hygienist and the physician should find something in the public mind to which they can appeal; some little stock of universally-acknowledged truths, which may serve as a foundation for their warnings, and predispose toward an intelligent obedience to their recommendations.

Listening to ordinary talk about health, disease, and death, one is often led to entertain a doubt whether the speakers believe that the course of natural causation runs as smoothly in the human body as elsewhere. Indications are too often obvious of a strong, though perhaps an unavowed and half-unconscious, undercurrent of opinion that the phenomena of life are not only widely different, in their superficial characters and in their practical importance, from other natural events; but that they do not follow in that definite order which char-

[1] A paper read at the Domestic Economy Congress, held in Birmingham, England, July 17–19, 1877.

acterizes the succession of all other occurrences, and the statement of which we call a law of Nature.

Hence, I think, arises the want of heartiness of belief in the value of knowledge respecting the laws of health and disease, and of the foresight and care to which knowledge is the essential preliminary, which is so often noticeable; and a corresponding laxity and carelessness in practice, the results of which are too frequently lamentable.

It is said that, among the many religious sects of Russia, there is one which holds that all disease is brought about by the direct and special interference of the Deity, and which, therefore, looks with repugnance upon both preventive and curative measures, as alike blasphemous interferences with the will of God. Among ourselves, the "Peculiar People" are, I believe, the only persons who hold the like doctrine in its integrity, and carry it out with logical rigor. But many of us are old enough to recollect that the administration of chloroform in assuagement of the pangs of childbirth was, at its introduction, strenuously resisted upon similar grounds.

I am not sure that the feeling, of which the doctrine to which I have referred is the full expression, does not lie at the bottom of the minds of a great many people who would yet vigorously object to give a verbal assent to the doctrine itself. However this may be, the main point is that sufficient knowledge has now been acquired of vital phenomena to justify the assertion that the notion that there is anything exceptional about these phenomena receives not a particle of support from any known fact. On the contrary, there is a vast and an increasing mass of evidence that birth and death, health and disease, are as much parts of the ordinary stream of events as the rising and setting of the sun, or the changes of the moon; and that the living body is a mechanism the proper working of which we term health; its disturbance, disease; its stoppage, death. The activity of this mechanism is dependent upon many and complicated conditions, some of which are hopelessly beyond our control, while others are readily accessible and are capable of being indefinitely modified by our own actions. The business of the hygienist and of the physician is to know the range of these modifiable conditions, and how to influence them toward the maintenance of health and the prolongation of life; the business of the general public is to give an intelligent assent, and a ready obedience based upon that assent, to the rules laid down for their guidance by such experts. But an intelligent assent is an assent based upon knowledge, and the knowledge which is here in question means an acquaintance with the elements of physiology.

It is not difficult to acquire such knowledge. What is true, to a certain extent, of all the physical sciences, is eminently characteristic of physiology—the difficulty of the subject begins beyond the stage of elementary knowledge, and increases with every stage of progress. While the most highly-trained and best-furnished intellect may find

all its resources insufficient when it strives to reach the heights and penetrate into the depths of the problems of physiology, the elementary and fundamental truths can be made clear to a child.

No one can have any difficulty in comprehending the mechanism of circulation or respiration, or the general mode of operation of the organ of vision; though the unraveling of all the minutiæ of these processes may, for the present, baffle the conjoined attacks of the most accomplished physicists, chemists, and mathematicians. To know the anatomy of the human body, with even an approximation to thoroughness, is the work of a life, but as much as is needed for a sound comprehension of elementary physiological truths may be learned in a week.

A knowledge of the elements of physiology is not only easy of acquirement, but it may be made a real and practical acquaintance with the facts, as far as it goes. The subject of study is always at hand in one's self. The principal constituents of the skeleton, and the changes of form of contracting muscles, may be felt through one's own skin. The beating of one's heart, and its connection with the pulse, may be noted; the influence of the valves of one's own veins may be shown; the movements of respiration may be observed; while the wonderful phenomena of sensation afford an endless field for curious and interesting self-study. The prick of a needle will yield, in a drop of one's own blood, material for microscopic observation of phenomena which lie at the foundation of all biological conceptions; and a cold, with its concomitant coughing and sneezing, may prove the sweet uses of adversity by helping one to a clear conception of what is meant by "reflex action."

Of course, there is a limit to this physiological self-examination. But there is so close a solidarity between ourselves and our poor relations of the animal world, that our inaccessible inward parts may be supplemented by theirs. A comparative anatomist knows that a sheep's heart and lungs, or eye, must not be confounded with those of a man; but so far as the comprehension of the elementary facts of the physiology of circulation and of respiration and of vision goes, the one furnishes the needful anatomical data as well as the other.

Thus, it is quite possible to give instruction in elementary physiology in such a manner as not only to confer knowledge, which, for the reason I have mentioned, is useful in itself; but to serve the purposes of a training in accurate observation, and in the methods of reasoning of physical science. But that is an advantage which I mention only incidentally, as the present conference does not deal with education in the ordinary sense of the word.

It will not be suspected that I wish to make physiologists of all the world. It would be as reasonable to accuse an advocate of the "three R's" of a desire to make an orator, an author, and a mathematician, of everybody. A stumbling reader, a pot-hook writer, and an

arithmetician who has not got beyond the rule of three, is not a person of brilliant acquirements; but the difference between such a member of society and one who cannot either read, write, or cipher, is almost inexpressible; and no one nowadays doubts the value of instruction, even if it goes no further.

The saying that a little knowledge is a dangerous thing is, to my mind, a very dangerous adage. If knowledge is real and genuine, I do not believe that it is other than a very valuable possession, however infinitesimal its quantity may be. Indeed, if a little knowledge is dangerous, where is the man who has so much as to be out of danger?

If William Harvey's life-long labors had revealed to him a tenth part of what may be made sound and real knowledge to our boys and girls, he would not only have been what he was, the greatest physiologist of his age, but he would have loomed upon the seventeenth century as a sort of intellectual portent. Our little knowledge would have been to him a great, astounding, unlooked-for vision of scientific truth.

I really see no harm which can come of giving our children a little knowledge of physiology. But then, as I have said, the instruction must be real, based upon observation, eked out by good explanatory diagrams and models, and conveyed by a teacher whose knowledge has been acquired by study of the facts, and not the mere catechismal parrot-work which too often usurps the place of elementary teaching.

It is, I hope, unnecessary for me to give a formal contradiction to the silly fiction, which is assiduously circulated by fanatics who not only ought to know, but do know, that their assertions are untrue, that I have advocated the introduction of that experimental discipline which is absolutely indispensable to the professed physiologist, into elementary teaching.

But while I should object to any experimentation which can justly be called painful, for the purpose of elementary instruction, and while, as a member of a late Royal Commission, I gladly did my best to prevent the infliction of needless pain for any purpose, I think it is my duty to take this opportunity of expressing my regret at a condition of the law which permits a boy to troll for pike, or set lines, with live-frog bait, for idle amusement, and, at the same time, lays the teacher of that boy open to the penalty of fine and imprisonment if he uses the same animal for the purpose of exhibiting one of the most beautiful and instructive of physiological spectacles, the circulation in the web of the foot. No one could undertake to affirm that a frog is not inconvenienced by being wrapped up in a wet rag, and having his toes tied out; and it cannot be denied that inconvenience is a sort of pain. But you must not inflict the least pain on a vertebrated animal for scientific purposes (though you may do a good deal in that way for gain or for sport) without due license of the Secretary of State for

the Home Department, granted under the authority of the vivisection act.

So it comes about that, in this present year of grace 1877, two persons may be charged with cruelty to animals. One has impaled a frog, and suffered the creature to writhe about in that condition for hours; the other has pained the animal no more than one of us would be pained by tying strings round his fingers, and keeping him in the position of an hydropathic patient. The first offender says, "I did it because I find fishing very amusing," and the magistrate bids him depart in peace; nay, probably wishes him good sport. The second pleads, "I wanted to impress a scientific truth, with a distinctness attainable in no other way, on the minds of my scholars," and the magistrate fines him five pounds.

I cannot but think that this is an anomalous and not wholly creditable state of things.—*Nature.*

COSMIC AND ORGANIC EVOLUTION.

By LESTER F. WARD, A. M.

THE evolution of a world is not obviously identical with the evolution of an organism. From one point of view they may be regarded as, to a certain extent, opposite processes. Fully understood, they are different manifestations of one process, affected by very different circumstances. Regarding each as an aggregate which must equally run its course, the special histories of the two are quite unlike. The history of every aggregate consists of two parts, a rise and a decline. It has its period of growth and its period of decadence. The first consists in a gradual progress from a diffused toward a concentrated state; the second is the return from the concentrated to the diffused state. The process involved in the first period is the integration of the matter of the aggregate, and the dissipation of its motion. In the second period this process is reversed: its matter is disintegrated, and motion is evolved. The first of these processes is termed evolution; the second, dissolution. In theory this is identical in all aggregates, and therefore the life-history of a plant is the same as that of a star.

But, while we may trace and understand the process in the former of these aggregates, and may declare such to be its law as the result of more or less accurate experimental proof, this is not the case with the latter. We see the varied forms of life spring into being and vanish out of being. We may watch them during their entire history, from the moment when they emerge from the imperceptible to that in which they are again lost in the imperceptible. We can ob-

serve all the processes of concentration, of differentiation of parts, and of integration of the whole, as well as those of equilibration, of decomposition, and final dissolution. Not so with the planet. Whatever theory may suggest or require, we are forced to confess a profound ignorance of the final destiny of worlds. So far as we are able to observe, the universal tendency of all matter is from the indefinite and homogeneous to the definite and heterogeneous; from a state of unstable to one of stable equilibrium. But this is only the morning of the life of any aggregate. We have no reason to suppose that, in all the myriad worlds of visible space, a single star presents to our gaze a condition representing the evening of its life. In the light of all our knowledge of the heavenly bodies and of the nebulæ, we study with absorbing interest the history of our own planet. From the confused gaseous condition in which it is supposed to have originally been, its motion has been gradually dissipated and its matter integrated, until only a comparatively thin envelope of gas—the atmosphere—remains. The rest has all assumed either the liquid or the solid form, the latter of which presents the nearest approach to complete stable equilibrium. And it can scarcely be doubted that this process still continues, and will continue, until ultimately this omnipresent *eremacausis* shall also reduce the waters and the atmosphere to the condition of stability and solidification—a state of planetary existence which many suppose our satellite to have already reached.

And may not this same law be called in to explain the heterogeneity of elementary matter, as known to chemistry? If all matter is primordially identical, as so many philosophers have dreamed, is it not philosophical to assume that our sixty-five known elements represent so many states of heterogeneity, so many distinct kinds of primary aggregates, which the matter of our globe and other worlds has taken on in its course from complete homogeneous instability toward its ultimate condition of stable equilibrium, as represented in what we know as solids?

However this may be, it is at least true that, so far as regards purely cosmical processes, the ascending series is the only one observable by us. For the "dead star," be it understood, represents, in the grand cycle of the redistribution of matter and motion, the *meridian* of its life, and not its close. Complete equilibration is the last act in the drama of evolution, and must be attained before the forces of dissolution commence their work. But we look in vain for any signs of the dissolution of the universe. Whatever theory may require, the fact ever remains that the process which we see going on in our portion of space is the process of evolution only. We see only the integration of matter and the dissipation of motion. We see only the tendency toward the condition of stable equilibrium. We see only the absorption of the gaseous and the establishment of the solid form of matter. All the theories by which it has been sought to compen-

sate for the radiations of luminous bodies have proved mere speculations. We know that the sun is radiating its heat into space; we do *not* know that space is returning this dissipated motion, either to the sun or to any other centre. We see planets and stars in various stages of their progress toward the stable state; we have no reason to believe that any are in the condition of transition from the stable to the unstable state.

The moon is supposed to have already passed through most, if not all, of its stages from the gaseous to the solid condition. Its atmosphere has been absorbed, its waters have retreated into its interior or perhaps been converted into solids, and all its visible activities have apparently ceased. If there still exist volcanic activities upon it, as certain observations seem to prove, they are probably the only ones, and are themselves declining. Doubtless there are other bodies in our solar system whose equilibration is even more complete than that of the moon—as, perhaps, some asteroids, or the satellites of the outer planets. They have run their long cosmical course, and have arrived at last at the final state of complete, stable equilibrium. This state is the goal of the whole process of evolution. It must, therefore, be regarded, when viewed from this standpoint, as the state of greatest perfection in the life of every aggregate. Many of the heavenly bodies have certainly advanced far toward this condition, and all are undoubtedly approaching it. But where is the evidence that any have commenced to reverse this process? What star is suspected of being in a state of disintegration? Where in all the universe do we see solids turning into liquids, and liquids into gases? Where and how are the radiations emitted by concentrating bodies being harvested again, and applied to the disintegration of completely integrated matter? In a word, amid all these manifest proofs of evolution, what proof exists of dissolution regarded as a cosmical process? We are bound to confess that there is none. We are justified in its assumption on *a priori* grounds alone, if at all. The law of the conservation of energy, now so well established in all the departments of physics, must be theoretically extended to the mechanics of space. This law is only another expression for the indestructibility of motion. If no motion can be destroyed, the same quantity must always exist in the universe. And as motion is necessarily nothing more than the local change of material atoms, all the solar and astral radiations must continue for all time to affect the same quantity of matter to the same extent. Hence these radiations cannot be wholly lost. Still, all this may be true, without affecting the question of the dissolution of worlds. The minute fraction of the sun's heat which is intercepted and absorbed by the different bodies of the solar system is utterly insufficient to ever effect their disintegration; and it is continually diminishing as the sun itself approaches the term of its existence: *a fortiori*, no such results can ever be produced by any of the more remote

radiating bodies. All this motion is projected into space, and the history of its future work is wholly beyond our comprehension. It may continue to affect the ethereal atoms pervading space for all eternity, without exerting an appreciable influence upon concentrated matter. Even our right to project the law of conservation into the realms of space, where we daily see motion dissipated but never recomposed, has been called in question. Have we the right to assert that this motion, lost to our system, is not lost to the universe? True Science well knows how here to suspend its judgment, but it also knows how to restrain the hopeless cry of *ignorabimus*.

Mr. Herbert Spencer is therefore right in making evolution the fundamental principle of philosophy, and regarding dissolution, which is its exact opposite and correlate, as practically of very inferior importance. For, so far as the earth itself and the heavenly bodies are concerned, the very existence of such a process is in doubt. So far as our knowledge of the universe, as such, extends, but one law is anywhere observable, and that is the law of evolution. Indeed, evolution is but the process of which the principle is gravitation. Evolution is the concentration and integration of matter; its tendency is toward the condition of stable equilibrium. The *con*traction of a body is due to the *at*traction of its molecules. Gravitation alone can explain this tendency, and gravitation necessarily requires it. Evolution is therefore coextensive with gravitation. Wherever gravitation prevails, evolution must prevail. On the contrary, a condition of dissolution would require the prevalence of a force the reverse of gravitation—a repulsive and expansive force. Our acquaintance with the visible universe reveals no region of space where we can assume the prevalence of such a force. On the contrary, many fixed stars, and even nebulæ, afford the strongest evidence of being under the dominion of an attractive force. Not, however, but that there exists in the universe abundant evidence of the possibility and reality of a repulsive or dissolving force. This is found, and with the greatest certainty, within the scope of our daily observation of the facts about us. And in at least one instance it is assumed, with a high degree of proof, to manifest itself in regions beyond the limits of terrestrial influence. I refer to the behavior of the tails of comets at perihelion. But wherever we see this force of repulsion, which alone could effect the dissolution of the aggregates already formed, it is wholly subordinate to the force of attraction which has formed them. Phenomena of this nature are but episodes in the history of a system or of a world. Everywhere the opposite phenomena predominate. Everywhere the force of gravity is evolving new aggregates, and bearing old ones on to their final state of complete equilibration.

Let us now turn to the second branch of our subject, and glance for a moment at the phenomena and laws of organic evolution. The first fact that presents itself is, that its primary condition is the influ-

ence of the sun. However it may have been at one period of the history of the earth, when its internal temperature may have been of a nature to favor the development of organic life without the sun's aid, by the earth becoming itself a sort of sun, it may at least be now affirmed that the solar radiations are the sole condition of vital existence on the globe. This fact is so apparent that even savages have generally recognized it, and science has scarcely been able to qualify the popular conception. By the aid of the sun's heat and light the various forms of vegetable and animal life have been evolved. By the same influence, year by year, the buds, and flowers, and leaves, unfold to the elements, and renew their conditions of growth and reproduction. By means of it the waters of the globe are in part converted into vapor and gas, in which state alone they are adapted to the supply of organic beings. By its influence the various organic bodies on the surface of the earth are finally disintegrated, and the materials for new forms and new beings are dissipated into the gaseous form, for recomposition and reutilization. By the same influence the waters of the globe are prevented from solidifying, and made the abode of millions of organic beings. In a word, it is the influence of the sun which alone renders our planet a habitable globe.

But what is the nature of this great and wonderful influence as expressed in the terms of the redistribution of matter? However paradoxical it may seem, it is nevertheless true that the great life-creating and life-sustaining force of the sun is cosmologically a *disintegrating* force, a force of *dissolution*. Indeed, the solar and sidereal radiations are the only examples which the whole universe presents to us of such a force. It seems strange enough to be compelled to ascribe all the phenomena which have been embodied in the term organic evolution to the action of a force which is the precise opposite of evolution, and which ultimately accomplishes the dissolution of every such aggregate. Yet it is only because the sun is in a state in which its matter is being integrated, and its motion radiated into space, that our earth is capable of producing the forms of organic life. It is only because a portion of this motion, ejected from the sun, is intercepted and absorbed by the earth, by which a portion of its own matter is disintegrated, and its own course of evolution is in so far arrested that the presence of the beings peopling it has been made possible. It is only through cosmical dissolution that organic evolution can go on.

Is life, then, a process of dissolution? Is organic evolution a misnomer? Are the unfolding of the bud, the branching of the tree, the hatching of the egg, the differentiation of the animal—are these but so many steps which concentrated matter is taking toward its final disintegration? Is development the antithesis of evolution? To all these questions a negative answer may, I think, be given. But we have gone far enough to perceive that some broad distinction exists between

cosmic and organic evolution. Let us examine this distinction more closely. We know that an organism develops, much like a world, out of an homogeneous and diffused state of its elements. Throughout its course the organic aggregate behaves like other aggregates. From the imperceptible it becomes perceptible. From the diffuse it becomes concentrated. From the indefinite it becomes definite. From the homogeneous it becomes heterogeneous. From the unstable it approaches the stable condition. Segregation, which is the selective process, is more marked in the organic than in the inorganic aggregate. Its parts are differentiated and rendered distinct and definite, while through an increasing dependence between them the whole aggregate becomes more and more firmly integrated or consolidated. Growth, which is increase of bulk, is simply the absorption of diffuse gaseous or liquid materials, which may theoretically be regarded as having originally belonged to the aggregate in its most widely diffused condition. Development, which is increase of structure, is the same process which all aggregates undergo in their transition from the homogeneous and indefinite toward the heterogeneous and definite, under the laws of segregation and the multiplication of effects. Finally, equilibration in organic aggregates is distinct and universal.

Every organism must reach this stage, and that in a comparatively brief period—so brief as to be capable of repeated and easy observation. So plain does this stage of its progress become that it is feared that the predication of a stage of equilibration, not to say dissolution, for inorganic aggregates, is an argument from analogy, where the analogy is taken from a very subordinate class of phenomena, viz., from the observed equilibration of organic aggregates. A universal conclusion is deduced from a particular case; the law of the whole is assumed from that of a part. This, according to Mr. Spencer's own showing in his "Principles of Psychology," is the weakest form of reasoning. It should be admitted, however, that while the doctrine of the ultimate disintegration and dissolution of the celestial bodies rests on very insufficient inductive evidence, there are strong *a priori* grounds, beyond the domain of science, but clearly within the range of philosophy, which make it a legitimate object for the exercise of the "constructive imagination."

The most important truth which can be called in to aid us in this difficulty and apparent confusion of phenomena is that of the perpetual competitive operation of both the forces of evolution and of dissolution. Both these influences are at all times and in all kinds of aggregates simultaneously at work. The history of every aggregate is that of its struggle with these opposite contending influences. The final equilibration implies this. It is the establishment of equilibrium between just these forces. In the evolution of a star the forces of dissolution are mostly within the aggregate. In that of a star-system they seem to be wholly so. The process of evolution goes on against

the inherent tendencies to dissolution. The equilibrium reached is between the attractive or integrating and the repulsive or disintegrating forces. Both are at all times active, and, if the latter at last prevail and the mode of redistribution is reversed, the gravitative influence still continues to oppose its progress. In an organism the disintegrating tendencies are chiefly from without. Everywhere on the globe the sun's influence is tending to prevent the integration of the liquid and gaseous elements. Life is the product of this struggle.

It may be laid down, as a universal law of the redistribution of matter, that organization is the product of the antagonistic tendencies of attraction and repulsion during the period in which the former prevails. Organization is, then, the great distinguishing characteristic of the process of evolution. The organization of the solar system is the result of this competitive struggle between these two agencies. It is the same with an organism. We have, then, at last reached a plane of generalization in which the cosmical and the organic processes may be regarded as parallel and homologous throughout. The active principle which directly results in organization is that which Mr. Spencer denominates *segregation*, by which the like parts are brought together and unlike parts separated.

The final result of this process is the formation of many distinct and definite parts which are unlike one another—heterogeneous. Each of these definite parts, differing from all the rest in the same aggregate, is, within itself, homogeneous, i. e., consists of a uniform internal structure. The like particles, in consequence of the similarity of their properties, naturally gravitate to the same place. In the case of the earth the atmosphere or gaseous portion forms a uniform envelope around it, due clearly to the nature and homogeneity of its molecular constitution. The waters, for the same reason, form a partial second envelope within this. The hardened crust of solid matter comes next, and in like manner the entire organization of the earth might be explained. Exactly the same process takes place in a living organism. Its various organs, vessels, specialized tissues, and differentiated parts, are the result of this same law of mechanical selection. The difference in the properties of the matter of each is at once the cause of their segregation and of their organic function.

The point at which we have arrived, therefore, is this: Organization is the necessary consequence of the competition of the integrating and disintegrating forces, so long as the former prevail. The influence of the sun upon the matter of the globe is toward its disintegration and dissipation into gas. But for the opposing influence of gravitation, attraction, or concentration, this result would be speedily accomplished. But the resultant of these two antagonistic forces, at a time when their relative power is substantially what it now is on the surface of our globe, is such as to render possible the form of evolution which we denominate organic life. A certain amount of the

matter of the globe is in the gaseous form. The gases themselves are differentiated into what we call oxygen, nitrogen, carbonic acid, and aqueous vapor, each of which exerts its special influence in the economy of vital existence, and without any one form of which, so far as we can see, life would be impossible. Another portion of the matter composing the earth exists in the liquid state, the chief form of which is water, of which more than half the weight of all organized beings consists. Evidently without water nothing answering to our conception of life could exist. Of the solid matter of the globe there exists the greatest heterogeneity, and it may be classified in a variety of different ways. Many, though probably by no means all, of the so-called distinct substances known to us are of direct value in the formation of organic tissues, and certain of them are clearly indispensable, so far as we understand their office; as, for example, lime, phosphorus, iron, etc., etc. Certain of these substances are crystalline, others colloid in their structure, the latter of which possess peculiar adaptations to the formation of organic tissue. Finally, between the solid and the liquid state there exist all grades of transition, thus adding variety to the organic adaptations.

As the universal law of concentration or integration proceeds to reduce all these varied forms to one, and to cement all in a single homogeneous solid, it is met by the powerful but somewhat irregular and erratic force of the solar radiations, reënforcing the inherent cosmical influences already so far overcome in the evolution of the planet as to have brought it to its given state. The result of this conflict of forces is the condition in which we find our globe. Without the aid of the sun's rays, organic evolution might have been impossible. Without the aid of the cosmical force of concentration, in a certain way counteracting without neutralizing them, it would have equally been impossible. With such a predominance of the one as has probably prevailed in the past, or of the other as will probably prevail in the future, the particular form of evolution required to develop what we know as life seems also beyond the range of scientific probability. A few degrees more either of heat or of cold are sufficient to utterly destroy it. Of the latter, we have a near approach to a positive example in the state of things existing in regions round the poles of the earth's axis. Of the former, artificial proofs are easy, and certain desert regions of the globe constitute partial illustrations, easily completed by the imagination.

We thus learn what a precarious thing life is, within what narrow limits it is circumscribed, upon what slender conditions its possibility depends; contemplating which, we may be appalled to reflect how small a portion of the concentrated matter of space must be presumed to fall under these conditions. For, even if every world in space passes through this organic period, its duration must be ephemeral compared with the vast cycle of its existence.

The important truth that it has been sought to reach by these considerations is, that organic evolution is but one of the minor manifestations of universal evolution. It occurs at a stage of the process when the struggle between the contending forces is very great, if not at its greatest. It is the immediate product of that struggle, and cannot exist when either the one or the other greatly predominates. The force to which we universally ascribe all possibility of life is the force which is tending to disintegrate the matter of the globe by absorbing the motion of the sun. The force which constitutes evolution proper is that which bears down all life and reduces the face of Nature to a desert waste. The interaction of these two forces, where they are suitably proportioned, effects the organization of portions of the matter on the globe, and organization itself is life. The period of greatest organic perfection on a planet is therefore very different from the period of its greatest cosmical perfection, which corresponds with that of complete equilibration. Cosmical evolution is the history of the universe, organic evolution is a transient episode in the life of a paltry planet. We can only console ourselves with the belief that, but for this trifling digression of Nature, no being would have existed capable of formulating the laws of the universe.

Organic evolution must not, however, be restricted to the mere span which the life of an individual represents. To fully comprehend its scope, the conception of the organic aggregate should be extended to embrace all the life, past, present, and future, on the globe. The mysterious process of reproduction, unknown to all other aggregates, has the effect of binding all living organisms into one continuous whole, and giving to all terrestrial life the stamp of unity. The individuals of a race or species do not represent so many distinct aggregates. The qualities of antecedent forms, whether inherited or acquired, are transmitted to subsequent forms, thus conserving, as it were, all the organization previously evolved. Although the dissolution of the individual aggregate takes place, the work of evolution which has been going on within it is passed on to a new generation, to be there continued and again transmitted. The individual, therefore, becomes of comparatively small importance. The real organic aggregate is the race. The race alone is capable of receiving and preserving all the products of organic evolution. Ontogenetic development is lost sight of in the march of phylogenetic development. The individual is merged in the species, the species in the genus, the order, the class, and all are finally swallowed up in the *tout ensemble* of organized existence. Organic being, as such, is the final term to which the generalization must be carried before the true scope of organic evolution can be adequately grasped by the mind. Individuals perish and are decomposed; species become extinct; genera, families, and whole classes, are swept from the earth. The broadest divisions into which the organic kingdoms of Nature have been classified have each their

periods of ascendency and decline. But organic evolution ever continues. Progress in organization is the constant result. It is always, on the whole, the less organized that gives way to the more organized. If the rich and exuberant cryptogamic vegetation of the Carboniferous epoch has dwindled away into the insignificant cryptogamic vegetation of our time, it has been succeeded by a phænogamic vegetation of far higher organization and nobler qualities. If the great saurian dynasty that ruled the Cretaceous age has surrendered its sceptre and disappeared from the stage of terrestrial life, a far higher mammalian dynasty, at whose head man now stands, has taken up that sceptre and is moving on to still loftier heights of organic development.

We have thus arrived at the highest point from which the phenomena of organic evolution can be surveyed. What do we see? We see that, in proportion as our point of view rises, the relative importance of the phenomena of dissolution to those of evolution diminishes. We see that the dissolution of the individual aggregate affects but little the evolution of the race-aggregate, and not at all that of the complete life-aggregate of the globe. We see that, amid all the evanescent forms that surround us, the evolution of life is constant; that of organic being as such there is no dissolution. We thus find the parallelism between cosmic and organic evolution, which at the outset seemed so paradoxical, and afterward so imperfect, to be at last complete. In the one as in the other, the only phenomena which we know to be universal are those of evolution. In the one as in the other, the opposite class of phenomena are wholly subordinate, special, and local. In the one as in the other, the forces of attraction and repulsion, of integration and disintegration, are in perpetual conflict. In the one as in the other, the organization of matter is the result. Just as the doctrine of the ultimate dissolution of the bodies of space rests on *a priori* deductions alone, unsupported by empirical observation, so must the final disorganization of the life of our globe be inferred from cosmological principles, which transcend the present limits of astronomy and physics. So far as we are capable of penetrating the mysteries of space or of life, we find that evolution is the law of the universe; while the forces which oppose that law, though powerful and ever active, are secondary and subordinate, and only seem to reverse it by the destruction of transient forms. In the genesis of world-systems this counter-evolutionary force consists in the inherent expansive power of diffused matter, or, what amounts to the same thing, in the resistance which such matter offers to the forces of condensation. In the phenomena of life this resistance comes chiefly from the sun, whose thermal radiations tend to dissipate the elements of the globe.

We are thus brought into full view of the deepest truth that underlies the redistribution of matter—the profound antithesis be-

tween *gravitation* and *ethereal vibration*, which constitute, in the last analysis, the true correlative *principles* of which evolution and dissolution are the corresponding *processes*. These are the agencies which are at all times antagonizing each other in all parts of the universe, and whose exact equality in it seems to form a logical tenet of the modern cosmology. A certain golden mean between these forces, but in which the former must predominate, results in organization; star-systems are formed in space, and life is developed out of the planetary elements. Such appears to be the state of all the matter within the range of human observation. For, whatever may be the condition of other worlds or other regions of space, the phenomena of our world and our portion of space belong to the ascending series; and whatever may be the final doom of our planet and our universe, both are now in a state of progress, and are still rejoicing in the morning of creation.

PESSIMISM AND ITS ANTIDOTE.

By CHARLES NISBET.

THE consideration of general questions not admitting of definite answer, and always throwing us back on the consciousness of the extreme limitation of our knowledge, is not a profitable direction of mind, nor to be recommended as an exclusive study.

Still, occasionally, it may be wholesome, as it has confessedly a strange attraction for us, to journey to the confines of our little island of knowledge, and thence speculate a little on the trackless ocean of mystery to the navigation of which science and logic are alike inadequate. All true religion is founded on this consciousness of the infinite, of an ultimatum transcending our comprehension, but stimulating and exercising our faith.

The moral government of the world, the spiritual tendency, or indeed any dominant direction, of things, is not patent to the fleeting glance, does not reveal itself even to the most strenuous thought. The history of the world presents itself rather as a Jeremiad, as a bottomless chaos in which evil and good wrestle with each other for the mastery, and where evil generally boasts the vast majority of forces.

Savage countries lie thousands of years morally stagnating or decomposing, often physically starving, ground down under cruel despotisms and superstitions, reducing one another in perpetual warfares. The pages of the most favored countries show long chapters of declension, and the moral influxes, like angels' visits, only few and far between. The cause of Brutus opens the way to Cæsarism and death. Spain shares in the tide of new life, but that life is zealously extin-

guished, and the nation settles down to decay. Cromwell and his Puritanism introduce Charles II. and licentiousness. The Pilgrim Fathers, Washington, and other great men, lay with solemnity and greatness of mind the foundations of the United States, and is its history hitherto a satisfactory result? Nation after nation, Egyptian, Persian, Jewish, Grecian, Roman, Arabian, and Celtic, shoot into blossom in order to rot back into forgetfulness.

And if we take regard of the individual units that are always swarming by the millions into the world, what vast quantities get blasted out before they have well begun to cry, not to speak of the possible units frustrated of birth. And of those surviving the perils of the outset, how all get bruised and damaged sooner or later, till death comes and snuffs out the smoky tallow-lights! People made a great fuss at the time about the late William King Thompson, of Brooklyn, New York, ship-exploder, as if he had done something more than usually wicked, but now it is seen for the mere trifle it is. Say he exploded half a dozen ship-loads of men, was there, out of the six human cargoes that flew successively all at once into ten thousand pieces, as much as *one* individual that properly speaking ever lived, or lived other than the most insignificant sensational existence? At every change of the temperature of the atmosphere from heat to cold are not many thousands of aërial midges summoned, on very short notice indeed, from their gay discursions to face the solemnities of eternity? Animal existence is cheap as dust, the earth and stones only requiring some little mixing and kneading in order to turn off endless batches of men and women.

Consider the tens of thousands always being born in our large cities, who by bad parentage, bad conception, foul air, foul food, and all manner of evil influences, get at once summarily stamped and sealed off to depravity and perdition. Think how in all our towns are houses where choice human cattle are kept, fed, and dressed, their soundness attested (on the Continent) by qualified officials; and how your choicest human cattle, rejoicing in their spiritual culture, throng into these shows to inspect and purchase. And in this enlightened age we know this is Nature all the world over, and Nature must be obeyed.

We are proud of the present age as the triumph of trade and mechanism. And we know the high genius and aim of trade. Trade thinks only on a good balance, and is proud of a good balance, be it got out of the follies and vices of men or in whatever way. Trade is thinning the country, crowding the towns, swelling dukes' incomes, fattening distillers and brewers, disfiguring and reducing the human *physique*, blighting the tenderness of relations between man and man, checking you off the values of the different sorts of intellect and inspiration. And, thanks to the extreme nicety of our mechanical arrangements, we are cut down into the most fractional existences. As if the *disjecta membra* left on a field of battle were made to spin into

some sort of galvanic life! In the higher provinces, too, your intellectual men are distributed into departments and sub-departments as writers or speakers, while life in the walks of fashion is a game of consumption and show. And when on the part of busy men the day's arduous endeavors toward the continuance of sublime human life are accomplished, and leisure is left for reflection, then a glass of beer, a pipe, cards, coffee and cake, a game at billiards or whist, a novel from the circulating library, is illimitable scope for the spiritual faculties.

And if we turn to our highest spiritual institutions we see equal signs of prosperity. At all our famous universities droves of young men called "students" are invited to profane the holiest names and symbols under the pretext of studying them, as if the first and foremost condition to intellectual activity or "study" were not a certain degree of spiritual faculty, of purification of the heart. The towns where they are collected for spiritual culture they defile more scandalously than any other class which makes no pretensions to spiritual culture.

Even if we single, out of the whole range of human history, the few men of genius whom we are constrained to regard as the eminently favored and endowed of our race, we find what a broken career has been allotted to the most of them. Have not many of them, possessing courage to inspire, intelligence to enlighten, sensibility to refine the world, sickened under the languor of neglect or got embittered at the endless contradictions and misrepresentations of their fellows, dying at last as unfortunate men, unhappy to themselves, unbeneficial to their contemporaries? What an evil is the not unfrequent depravity of genius, and which under happier circumstances might have been a great salutary influence instead! Might not the tremendous forces of Swift, for example, have been turned to better account than left to explode in shocks of half-diabolic hate in earlier days, and in madness at the end? Think of the generous human heart, brave will, and clear head of Burns, a man of quite transcendent powers, yet fain to slink past on the shady side of the street, left to bleed so wretchedly to death in the midsummer of his days. Contemplate the great intellect and great heart of Lessing, a man of thrice excellent mother-wit and effectiveness, disposing with a lordly air of the whole literature of Europe, awakening with his clarion-voice his slumbering nation to new intellectual conquests, yet himself imprisoned for so many of his best years in the stifling library-dust of Wolfenbüttel, isolated there in the midst of an unhealthy swamp; the world such a dish of skimmed milk as to be incapable of any sense of honor. Was not Lessing's child a boy of remarkable sense, who no sooner came into the world than, seeing his mistake, made out of it double-quick? Is it not probable that many brave souls, braver and better perhaps than any known to fame, have gone down to silence unregarded, the world's stupidity being more than a match for the gods themselves? Think of good

Edgar in "King Lear," and had he been left to die a maniac, would that, think you, have been untrue to fact?

Even the one or two to whom Fate has been most propitious, a Shakespeare, a Goethe, have not they too suffered from the bruises or flattery of Fortune, fallen at any rate far short of the fullness and balance a happier age and education might have conducted them to?

People are indeed fond of raising monuments and holding centenaries (to the so-called honor!) of great men, but do you think there is any significance at the bottom of it? Very little indeed. The fathers kill the prophets, and the sons garnish their sepulchres.

In the face of these facts and considerations how disgusting to hear the universal cant about "public opinion!" The shoemaker's opinion may indeed have some value on the matter of boots, the tailor's on that of clothes; but what opinion can the masses, all absorbed in the question of simple existence, have about government and education and religion? At best they are capable of a total heart-belief in *names*, of dying as martyrs for *names*. Dean Stanley admits that most of the noble martyrdoms have been in attestation of peculiar combinations of letters of the alphabet. See the intellect and heart of Scotland wrangling, down into the latter end of the nineteenth century (and into how many later centuries?), as to whether little children at school shall learn how to define effectual calling and distinguish between justification, adoption, and sanctification!

And all men shall be immortal? Each despicable unit must needs be an immortal and independent soul? Came from God? And God sends by special appointment such swarms of immortal souls, often in such questionable way, sinto the world? And if you are really eternal the *one* way, *before*, you must also be so the other way, *behind?* What, then, of your being a thousand years ago? And you do seem to carry the air of eternity about you, sleeping and digesting and pottering about nothing as you do! Is not each individual man, according to Darwin and Haeckel, but the temporary inheritor and transmitter of the qualities of his ancestors, modified by the impressions received during his own tenure of life from intercourse with people, reading, etc.? And how can the self-same life be held at one and the same time by each individual successive link in an endless chain, seeing the life devolves but in succession, and that each link in the chain sparkles into existence and luminousness only during the short term of actual possession?

It is no use arguing that men are left to their own free-wills, and have themselves to blame for their fates, when the whole complaint is simply that men have no free-wills to be left to, but are total slaves. And yet not a poor devil desecrating the earth but, under very possible circumstances, through a kinder providence and better influences, might have been saved in the first place from being born a devil. Where, then, is the moral government of the world, the ideal tendency

of things, the high and lofty destinies, and all that? Schopenhauer and Bahnsen, earnest thinkers, arrive, after exhaustive examination and mature deliberation, at the conclusion that the world is not the best but the worst conceivable, the best possible issue for it annihilation, man's greatest misfortune birth, his greatest happiness death.

And yet the everlasting impossibility of accepting this as a final statement proves unquestionably its partiality—proves there must be quite a different and broader verdict. *Dum spiro spero;* respiration is aspiration. Life is hope, is struggle upward and onward. Healthy and robust life can set no final goal to its endeavors and hopes, but carries deep in its bosom the promise of quite an infinity of inheritance—dim and unconscious perhaps, yet latently warm and unquestioning.

Despair is death, declension from once recognized higher ideas is degeneration, violation of principles of honor and justice once recognized is inevitable injury. In the active furtherance of spiritual or universal ends alone has man solid and complete satisfaction. What is the meaning of the universal Jeremiad from the beginning of time till now but "the fall," the declension from the necessary justice and goodness? Down to the last stage of depravity the man is never at home in his depravity. It is always *de*pravity, and not native badness. The man's unsightliness, alienation from himself and his fellows, inward sense of bankruptcy and ruin, is an eloquent, pathetic sermon in behalf of the true. Injustice, selfishness, disavowal of obligations, seizure of others' property, never enriched or profited a man, but has always been so much inward contraction, induration, plethora, deliration—always so much disease involving so much pain, demanding so much expiation.

The subordination of self in the pious recognition of the eternal laws (= religion) and the adequate willing execution of the same (= art)—that alone is life, and a man is more or less according to the measure of his possession of this life. In the name of God, which is our highest expression of the world, is recognized something higher than our utmost sense of the just, good, and beautiful. If, then, our hearts go out in fervent, irrepressible longings of love toward the great men who have met on this planet the most unhandsome reception, if we demand that the heavy debt of love and esteem which was due to Lessing, for example, but never paid, be at last made good to him, that this excellent spirit, which out of a full heart would radiate to the quickening and enlightening of his country and Europe, do not strike his beams into emptiness, but that he himself also be gladdened by the warm reflection of his own light—is there, are we to suppose, nothing in the heart of things, nothing in the primal intellect and heart corresponding to this unsubduable demand on the part of our remote individual consciousness? Shall the mother-sun be less warm

than a reflex ray of itself? If, again, our hearts, though so poor and insensible, can yet break in salt sorrow over the confused helpless misery of the masses, is the prayer that bursts involuntarily from them not in accord with the heart of God himself? Is it a foolish and false impulse which Nature stirs in the heart of the mother when she recognizes a quite infinite value in the poor helpless chick newly-born to her? When Jesus Christ appeared as a symbol of love and mercy in this world, preaching the prodigal son, and proclaiming the God of this world to be a God of righteousness and compassion, could the hearts of his hearers remain insensible to the manifestation and the sermon? Have not the words been caught up as the truest gospel of the highest God? And in Jesus Christ, who felt an unspeakable interest even in the outcasts of society, and whose attitude toward the morally wrecked man, in whom desires and appetites had devoured all the handsome capital and prospects and possibilities in life, was *not* the side sniff of cold disdain, but condemnation into everlasting fire or an infinite yearning of compassion—in this appearance of Jesus Christ on earth have not men been constrained worshipfully to recognize the truest incarnation of God? Religion which sinks in us all personal regards, which would bring us into immediate communion with the Supreme, is ever a consciousness of inexhaustible resources—is more than a counterpoise for all the ills of life, and all the black facts which history can adduce—is a power which can dwarf all history, all the hitherto actual, into the insignificance of a mere prelude, and not an essential act in the drama of life itself.

Meanwhile, over and above this general reflection, which, if needed, can always serve as our last impregnable resource, it is possible to predicate particularly some of the advantages, and even the absolute necessity, of the confusion and misery everywhere attaching to reality.

This confused world of good and evil is the right arena and training-school for battle, enterprise, patience—for all the active and indeed also all the passive virtues. The baseness, stupidity, folly, injustice, suffering, and wreck, this world everywhere presents, are always a splendid challenge to strength, diligence, endurance, faith, wisdom—to all sublime and manly qualities. Sloth, indolence, sweet dreaminess, and credulity, have a hard time of it here—meet every day with the shrewdest rubs and tosses till they are either forced into wakefulness or gored into death. A long-living and prosperous nation must plough the soil, must sail the sea, must live much out-of-doors, must ever be prepared to defend its own against the whole surrounding world. And the artist or man of letters must not ensconce himself too much in his cozy study, but lay himself open to the shock of opposition and the misconstruction of his fellows, must not shrink from the experience of unkindly facts to try his nerve and test his digestion. Only to the man who lives industriously, moderately, honestly, truthfully, and piously, does God vouchsafe higher dis-

closures; and to the man who will eat the bread that has been by the labor of other hands procured for him without paying an equivalent, the kingdom of heaven is forever shut.

The personal pain, languishment, and imbitteredness, do not spoil for the brave man his appreciation of life, but by persistent faith and well-doing he subdues and converts contrarieties into furtherances. Socrates and Paul and Cromwell and Milton did not break their hearts or give up the fight. Lessing, after all the languor and sickness of Wolfenbüttel, refused to die, though he bore in his heart the deadly ravages of fate, till he had first presented to his ungrateful country his large-hearted offering of "Nathan der Weise." Nor was he egoistically looking forward to a world of happiness beyond the grave, as compensation for his sufferings, as reward for his magnanimous services.

> "He heeded not reviling tones,
> Nor sold his heart to idle moans,
> Though cursed and scorned, and bruised with stones."

Think what sort of world it would be without the pain and persecution. When in our church-pews our ears are tickled with the sweet eloquence about heaven, where there will be no tragedy, no pain, no tears, no trial of temper, no tempers, no passions, no black, all white, only white, everlasting singing, and so on, does not every masculine heart feel the most melancholy misgivings about the concern? would he not willingly sell out on that policy even at a liberal discount, could he but invest with the realized capital in this troublous yet withal interesting planet?

The truth is, the mixture and antithesis is the appetizing quality in the fare of life. The dangers, misunderstandings, jealousies, errors, and seductions, on the one hand; on the other hand the joy in healthy relations to the sensuous world, and in the æsthetic contemplation of it, the sense of the ludicrous and ridiculous evermore tickled by the wonderful conjunctions of the sublime and vulgar in human affairs, the feeling of heaven in true relations to our fellow men and women, in work accomplished and duty performed, the highest bliss of all in the recognition of, and nearer and nearer identification with, the Supreme Spirit; the sense, in short, of a hell on the one hand to be shunned, and a heaven on the other to be enjoyed—whoever vividly realizes all this will not underrate life on this planet, but infinitely prize it.

Yes, this earth is dear to mortal men, not merely in spite of its tears and crosses, but also on account of them. The bitterest experiences we pass through need but to drift to the due distance in the past, and they assume a wonderfully interesting guise. Strangely, tenderly affecting in the retrospect are our riotous "Hal" days, our sighing Venus and Adonis fit, our sultry Werther fever, our sweet and bitter Faust period, and all the other dear illusions which beset us on our devious path.

For indeed we prize life not by the sum of our possessions, but only by the rate and steadiness of our growth. "Not the possession," says Lessing, "or fancied possession of the truth, but the endeavor after it, determines a man's value. If God held in his right hand the sum total of truth, and in his left the ever-inextinguishable desire after truth, though linked with the condition of everlastingly wandering in error, and called to me, '*Choose*,' I should humbly close with the left and answer: 'Father, give me this; the truth pure and simple is for thee alone.'"

But if we will have cleared to ourselves at the highest court what it is that imparts to error, crime, and tragedy, their powerful attraction, so that they are indispensable to high poetry and music and art, we shall find it is only because they constitute a dark background to heighten the play of the lightnings, to glorify the splendor of the sun. The trial and sorrow and humiliation serve to bring out in distincter outline the faith and serenity and triumph which, as in St. Paul, are more than a match for all the powers of darkness. Our conviction of the dominance and necessity of moral law is so deeply grounded, that the storm and earthquake threatening its upheaval only summon into livelier consciousness our inexpugnable confidence. Let the heavens fall. Though the earth be removed, God is our refuge.

It is the conscious or unconscious conviction of every sound man that truth is better and more beautiful than any delusion—that a man's well-being is the measure of his conformity to truth. Does a man find his hitherto solid philosophy impugned, his most holy religion out of joint with new emerging facts, he will not shut his ears to the severe reason. Does Science come and knock from under his feet the ground of immortality on which he had rested, it may help only to startle him out of his egoism—startle him on to some firmer footing. He must feel the immortality in the present, and not postpone it to the future. Only he who has eternal life in him (= intellectual recognition of, and hearty identification with, eternal law) is eternal. If Darwinism is true, and a man's spiritual supremacy is also true, the two facts will square with each other. For mind and Nature are the type and impression, in perfect correspondence to each other. The harshest exception is, when properly understood, no exception but a confirmation of the beautiful law. Depth and wholeness of vision will always be song and piety, be Dante and Shakespeare, never skepticism and mockery. The reconciliation of the spirit with Fate and Nature is a grace which rests sweetly and unconsciously in the heart of simple goodness, but is also the crowning grace of the boldest intellect which has pierced deep enough. Plato, Shakespeare, Milton, Newton, Kant, Goethe, and Schiller, are reverent worshipers, and walk in the sanctuary above arm-in-arm with Christ and the apostles. We see, in the "Nathan der Weise," how the brave Lessing received before death in fullest measure the gift of reconciliation.

And out of the perplexities and corruptions and misunderstandings of human affairs we have in Nature, which ever over-canopies and surrounds us, a retreat into the beautiful, where we can evermore refresh our sense and conviction of the holy. The sun, stars, woods, grasses, shells, birds, and wild creatures, are not corrupt, or at least do not suggest to man, when he contemplates them as a whole (æsthetically and not scientifically)—do not suggest images of corruption; but the poor besotted wretch beholds a perfect splendor in the sun, the prey of ruinous appetites looks into an eye of innocence in the flowers, the bankrupt gazes around and above him, and wonders why in a royal palace he should be a blot and disgrace.

As soon as the man rises above his desires, and throws the roots of his being beyond the narrow confines of his egoism into the spiritual realm, where his own individual self sinks in other individuals, where other individuals become as much his proper interest as himself, then the soul becomes one with the universal soul, and perfect reconciliation is enjoyed. The man's past pains are healed, his very sins and sorrows yield themselves to him as experience and instruction and romance.

The devil himself is subdued into good. Job's latter days are more beautiful than his early days. Through his sorrows and errors, Faust at last attains to a wider and holier life. The attraction to Gretchen, notwithstanding the sensuous illusions, has, in the heart of it, a soul of love and sacredness, and through the deep welter of sin and suffering is purified at last into sanctity. Do you think Faust in the end would annihilate his experience of Gretchen if it were possible? No, the earth and heaven are dearer because of her. Gretchen is universalized, and the universal is Gretchenized; the world is all a sacred, pathetic Gretchen.

That an unhappy life may be happier than a happy one is indeed a paradox, but is meant in earnest. A tragedy is more delightful than a comedy. Or a comedy is better for a mixture, and strong mixture, of tragedy, so the tragedy only get digested in the end. Black is necessary not only to the relief, but even to the very composition of white. I should not choose a life of uninterrupted pleasure, were the world to engage its utmost to secure it me. The lightning is born of the darkness; and the battle, joy, and splendor of life are to be measured by the amount of opposition overcome.

> "They say best men are moulded out of faults,
> And, for the most, become much more the better
> For being a little bad."

Let us with assured hearts trust the Cause of all, who has created the good and the evil, but has, we believe, made the evil to be ultimately subservient to the good.—*Macmillan's Magazine.*

THE MODERN PIANO-FORTE.

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MUSICAL instruments with manuals or key-boards, and fixed tones, occupy a most important position in the annals of modern art. All the greatest composers have been skilled performers on such instruments, and especially on the piano-forte. They are very greatly indebted to it; not that their works have been produced by its aid, or that it has been allowed to exercise a formative influence over their imaginings, but because of its companionship and sympathy. The creator of new musical forms, while engaged in his silent work—in the comparatively slow process of writing the individual parts for all the instruments employed in the orchestra—not only exercises the faculty of expression, but also the power to withhold. This power—this muscular strength of the brain, to grasp and retain whatever has been conceived, notwithstanding the perplexity as to means of expression, which commonly attends a crowd of ideas and feelings—is sometimes in danger of being overtaxed. On these occasions great relief is found by opening the piano-forte, and throwing off the piece at full speed on this plastic instrument. After realizing his ideals in this immediate and satisfactory manner, the composer returns refreshed to his patient labor—to the detailed record on paper of those emotions which fill him with such passionate energy. Or, should he wish merely to find relief in utterance—to commune with himself, and obtain recreation by driving temporarily from his thoughts the work in hand—then this comprehensive instrument, this miniature orchestra, enables him to extemporize elaborate contrapuntal forms, clashing cyclopean harmonies, or highly-involved melodic strains. The sounds thus evoked fall back on his delighted ear, exhibiting to him, in audible form, his psychologic condition. During these fleeting moments he thus beholds his subjective state, as clearly and definitely as in a mirror he would see, similarly reflected in visible form, the expression of his countenance.

But the piano-forte, by making domestic music at all times easily and immediately attainable, without the preliminary adjustments required for the harp or other stringed instruments, has become universally popular. Its literature is larger than that of any other, and whatever musical forms have found favor with the public are immediately adapted and rearranged for reproduction on it.

The piano-forte appears in four principal forms: as grand, square, upright, and curved, the latter being a newly-designed model, by Mr. J. W. Otto, of St. Louis, Missouri. The American grand piano-forte

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is, however, the greatest triumph of inventive genius and skill, aided by modern physical science; and this fact being acknowledged in all parts of the civilized world, foreign trade has been introduced to such an extent as to make the industry one of the largest in the United States. All the makers here daily strive for preëminence, and endeavor to surpass one another in the superior excellences of the smallest details, if not in the novelty and value, of their own respective inventions. No pains or expense are spared to obtain improvements, in the hope that these may, at least, lead to subsequent discoveries in the many untrodden paths of acoustical science. In this respect they resemble the old violin-makers of Italy, who also took a pardonable pride in their productions, which are the result of similar prolonged strivings.

The violin and the piano-forte, however, although in some respects similar, are in others widely different. The violin is endowed with perpetual youth. It even improves with age. The piano-forte does not. The violin is a mere shell of wood, modeled somewhat after a human shape, held together by glue, and strung with catgut; and although its various parts must be adjusted with great discrimination, and the bow with which it is excited be finely formed (having, for instance, a length of say twenty-nine and a quarter inches; weight of 900 grains; a diameter gradually decreasing, for twenty-three inches, from one-third to one-tenth of an inch, the curvature meanwhile increasing at an accelerating rate, to give a spring to the bow), yet this musical instrument, when compared with a piano-forte, appears as an extremely simple organism. It is more homogeneous, like all the other members of the numerous family of viols. The piano-forte, on the contrary, with its many kinds of wood, hard and soft, heavy and light; its many kinds of cloths and felts; of skins; with its masses of wrought and cast iron, steel, copper, brass, silver, lead, etc., is a more highly-complex production. It is heterogeneous, rather than homogeneous; and only by the most perfect coördination of all its parts does it retain an organization capable or worthy of preservation.

The piano-fortes of Erard, so highly prized for their extreme refinement and susceptibility to slightest variations of touch, are extremely delicate; and while other Europeans have succeeded in making more robust instruments, it has been reserved for the Americans the ability to endow their productions with constitutions capable of resisting, to any remarkable extent, climatal influences. The degree of their success, with reference to longevity, is not yet fully proved; and the variations in this respect are so great that it would be even rash to form an estimate, as we shall presently see. It is only safe to say that a piano-forte is never better than when it first leaves the hands of its maker. Like a young, impressionable being, it may then be made to suit special tastes and requirements. The readiness and extent of response to touch can then be determined, and the tones

may at once be made fuller, rounder, sweeter, harder, more brilliant and penetrating, or more sympathetic. It is vain to hope that they will be mellowed or otherwise improved with age or use.

For it is a common experience that piano-fortes differ greatly in the ability to retain their good qualities, even though subjected to the same conditions. It is also noteworthy that, although many instruments may be made precisely similar, and by the same workmen at the same season of the year, all other known things being also equal, they will differ in their characteristics, as children of the same family mysteriously differ from one another, although retaining many marked points of resemblance. It should, therefore, not cause surprise that among the 30,000 piano-fortes annually produced in the States some will be found so admirably balanced, so happily constituted, and adapted to endure great "wear and tear," as to survive mutilation, railway-accidents, extremes of heat and cold, dampness and dryness, and yet remain surprisingly vigorous and strong. Engineers and others acquainted with the conduct of iron—in suspension-bridges, for instance—which does not uniformly granulate, will not be surprised to learn that three strings struck uniformly with the same hammer may break at widely different periods, after losing their tenacity from the insidious nature of vibrations, and then from thermal changes rather than blows. But here we are not merely speaking of the strings, but of the piano-forte in its entirety—as consisting of a great number of mutually-depending parts, coöperating to a common end and the harmonious working of all.

To trace the gradual development of the piano-forte, from all its various archetypes, would occupy too much space. It is sufficient here to point out that virginals, spinets, clavichords, harpsichords, and various new forms of old types of similar instruments, were found incapable of further improvement. In the "struggle for existence" they failed to compete with the piano-forte, which, although at first far inferior, has finally survived them all. During the past fifty years, modern science has materially aided in enlarging its powers, especially in America; and it now claims our attention as the ultimate result of a long series of modifications superimposed on modifications which have led to what Mr. Herbert Spencer might designate as "an immense increase in the harmony between the organism and its environment."

European piano-fortes introduced by the early settlers here soon became useless. The dry land-winds of the interior, the moist sea-breezes of the coasts, the violent and sudden thermal changes, could not be endured. A new species had to be produced, for this one failed to become acclimated. The problem to be solved in those days was by no means an easy one. It was as difficult to improve upon the then existing piano-forte as it is to increase the capabilities of those we possess now. But the indomitable perseverance of sturdy souls

led them to face the difficulties resolutely, and devise "new internal relations" to meet "new external relations;" to bring about, as it were, a closer "correspondence between the organization and its environment." They learned that the "degree of life varied with the degree of correspondence;" that along with complexity of organization there goes an increase in the number, in the range, in the specialty, in the complexity of "adjustments of inner relations to outer relations," in what may perhaps be termed "the evolution of the piano-forte."

Their first, rather uncouth-looking instruments, with enormously large, solid wooden frames, appeared as an "unmixed breed," and therefore so far stable. They did not succumb so readily to the climate, and even presented peculiarities that attracted attention in Europe. The native woods of which they were made were found to be better adapted to the climate; polish was used even for the sound-boards, in preference to varnish, which evaporated, and other slight changes were adopted with great benefit. Yet still the requisite degree of strength could not be obtained from wood alone, and the comfortable classes using pile carpets, heavy curtains, soft cushions, and other warmth-retaining substances in their drawing-rooms, demanded a piano-forte that could make itself heard in the presence of so many deadeners of sound. Iron was then employed in combination with wood, but, the action of the two materials being by no means uniform under constantly-changing conditions, the desired equilibrium was not gained. In some instances the transverse swelling of the wood fractured the iron plates. Although this "mixed constitution" failed to meet the requirements then, the combination is now better understood.

The first intention of the application of iron—of the harp-shaped metallic ring—was not to enable the instrument to endure the constant strain of the strings. It was supposed that the metal would expand and contract uniformly with them, in the severe changes of this climate, and that in this manner the instrument would remain longer in tune, although the actual pitch might vary.

In 1837 the highly-skillful American maker, Mr. Jonas Chickering, conceived the bold idea of constructing a frame entirely of iron, and in the same year made his first square piano-forte in this way. In 1840 he produced the first grand piano-forte with an entire iron frame all in one casting. By this remarkable invention the piano-forte gained in truth an "iron constitution," competent to bear the atmospheric changes of this climate, and to it all subsequent successes are referred.

It was a great achievement to obtain a frame capable of resisting the enormous strain of the strings, but this advance imperatively led to innumerable variations being made in various details, for the attainment of an equilibrium, without which the promised gain could

not have been fully realized. The softer tissues still remained of wood of various kinds, and other such essential materials. With the acquisition of an iron frame or vertebra equal to the tensile strain of thirty tons without danger of fractures, came the temptation to employ strings of greater thickness, with a tension of from eleven to sixteen tons. These strings, stretched as near as possible to the limit of elasticity, that they might give forth the most vigorous vibrations, required to be set in motion by blows from hammers specially adapted for the purpose. (Voices similarly strained on the highest notes within their compass also have the most brilliant quality, as for instance the "G" of Mr. Santley and the chest "C" of Tamberlik.) Then, again, the increased powers of the instrument made greater demands on the sound-board.

If we compare the vibrations of the violin, set up by the comparatively gentle friction of the bow, with those of a piano-forte sound-board, violently trembling in response to strong percussive accents, and the multitudinous and continuous vibrations of long, thick metallic strings, it is at once evident that they are of a more extraordinary nature. Great discrimination was used in the selection of the wood from the spruce-trees of the Northern forests; many experiments were made to discover which way the grain of the wood should be disposed, and in what manner the sound-board should be compelled to receive and transmit impressions without fear of such derangements as should lead to a state of paralysis. To make it act most energetically the fibres were permanently compressed longitudinally, as in a vise, up to a certain point, similar to the strings, which, as we have just now seen, give forth tones of most satisfactory quality when stretched to the verge of breaking. There is a readily-found precise limit to this compression, after which the tones become hard and thin in quality. The sound-board is now also slightly curved, forced upward or made convex that it may resist the downward pressure of the bridge that holds the strings slightly elevated from their level, to secure a complete and intimate communion for the transmission of vibrations. It is clear that, if, from any cause, a sound-board should become concave, or loose at any of the sides, serious consequences would ensue. Considerations such as these sufficiently prove that the attainment of a perfect harmony among the parts, to resist successfully external influences, was no slight undertaking.

The American piano-forte has, however, attained a constitution that will endure dryness, cold, and even furnace-heat, but succumbs to excessive dampness. A good instrument, dried to the utmost, rapidly absorbs moisture. The well-fitted parts, having no room to swell, then become rigidly bound together, and thus the action is destroyed. It would therefore suffer if placed in a room having no subcellar, under which water-courses might be formed after rains. An inferior instrument made with damp materials and kept damp by

judicious sprinkling, ostensibly to allay dust, might thus successfully compete with a good instrument during an ordinary public exhibition, although it would soon prove worthless.

Varnish is now used for sound-boards and cases, both here and in England.

The constitution of the English piano-forte enables it to bear the English climate, in which the humidity is more uniform. When brought here it breaks down. But even the American piano-forte can only to a certain extent bear the trials from climatal changes to which it is subjected, and for a very limited space of time in some parts of the States, as, for instance, the Rocky Mountains. If a good instrument, made with native woods, seasoned for two years in the open air, and kiln-dried for three months at 130° Fahr., be removed in winter, while the thermometer is at zero, and placed in a heated concert-room, the sudden rise in the temperature, causing dampness, would affect the glue as well as the wood-work. But when organic derangements are not caused, a host of minor ailments set in which impair and gradually destroy a piano-forte. The metals corrode, the strings break, the pins holding the wires relax their hold, and then turn round (in inferior instruments), the felt on the hammers becomes worn, the damper actions rattle, the various centres loosen, the hammers (that deliver the blow before the key is fully down, and then immediately retire from the string, to allow it to vibrate and take up such a position as to deliver a number of consecutive blows with rapidity) may act with irregularity, or without the requisite vigor, and moths may attack the felt and cloth. Although many of such ailments yield to treatment, yet they are unmistakable signs of general decay. In forming an estimate, however, of the longevity of a piano-forte, one should reflect on his growing insusceptibility to sensuous impressions, and not institute comparisons with newer instruments of greatly-enhanced capabilities. It is well also to point out that sometimes articles of furniture, free to vibrate, will do so in sympathy with certain notes of the instrument, and thus make a supposed defect. Articles, such as a stiletto in a metal sheath, or a glass globe on a gasalier, are not readily detected in the act of responding.

On comparing piano-fortes by various makers it is well also to bear in mind the special peculiarities of each. The makers of the Erard piano desire to produce a brilliant, ringing effect, and do not destroy the numerous, tingling overtones which succeed the cessation of their primaries. Sensitive artists, who desire an achromatic quality, object to these, although they are intended to add a kind of harmonic halo or lustre to the general tone, which in a crowded drawing-room might appear dull and lifeless—wanting in radiance and animation. The Broadwood makers strive for the formation of a full, organ-like tone. The Collards are successful in obtaining flute-like and liquid tones, which in the treble are remarkably sweet and dulcet. The Ger-

man piano-fortes are generally rough and unfinished in mechanical details when compared with the French, although the tones are stronger.

Yet neither bear comparison with those of America. These also, among themselves, present marked characteristics. One maker prides himself on the magnitude and power of his instruments, and their fitness to be employed with the orchestra in large halls; another on the delicacy and extreme purity of the tone, which he deems can only be attained from instruments intended for the drawing-room or halls of moderate size; a third may try to obtain a "traveling-power," which quality is so markedly deficient in many upright pianos and in free-reed organs, as compared with grand piano-fortes and pipe-organs, that always sound better when at some distance. Great attention is always paid to the material and form of the hammer, which is found to produce the best tone when covered with soft felt, made of the wool of the merino sheep. This Saxony wool is worked here by Germans. Great care is also paid to the spinning of the covered wires, and the consistency of all the others to avoid defects that would lead to beats, and deceive the tuner.

Much experience and practical skill are required in the designing of the scales, or elaborate balancing of length, weight, thickness, material, and tension of the strings, to secure uniformity from bass to treble, while conforming to a given length of case, although the design may be planned in accordance with the mathematical theories of stretched strings. Then, again, the point where the blow is to be delivered is carefully chosen, that objectionable nodes may be destroyed. For the same reason wedge-like dampers are employed to check vibrations, and are made to act at a point where subsequent dissonant overtones may be rendered impossible. For the want of this last precaution, an otherwise valuable upright piano-forte, by a prominent firm in Germany, was pronounced a failure in London, some years ago. On striking any one of the bass notes, and then raising the key, after a short interval of silence, the harmonic seventh was generated; and this was no weak, vanishing tone, but a strong, continuous sound resembling that of a musical glass.

On studying the detailed accounts of new patents for improvements—real or imaginary—on comparing the statements of rival makers, or on being persistently contradicted by interested experts, one learns the difficulty of forming an opinion on points at issue, having reference to the advantages gained by alterations in the mode of constructing piano-fortes. It demands considerable special knowledge even to fully comprehend these points. One should carefully avoid expressing opinions that might tend to affect values, and be content with the reflection that the public at large is well enough informed to know that only those firms possessing the requisite capital, intelligence, and experience, can produce an intrinsically valuable instrument.

Cheaply-made piano-fortes are mostly sold to ignorant persons, living far from the great centres of civilization.

It will be found interesting to notice some of the facts learned by those who have conducted experiments in the hope of improving the piano-forte, for many of these are somewhat peculiar, and contrary to general anticipation. Thus: Chladni's figures are not formed by sand strewed on the sounding-board; nor does the sand travel from the point where the shocks or impulses are imparted to this vibrating body, but collects at this very point, namely, close to the bridge. Again, no difficulty is experienced by "interference," when two or three strings tuned in perfect unison vibrate side by side; nor from overstringing the bass wires. The fitting together of trough and crest of sound-waves—the coincidence of the "swing" and the "swang," which cancels both, and forms the hyperbolic curve of silence on the outer broad side of each prong of a tuning-fork, is a phenomenon that does not appear in any portion of the scale. Nor does that which is termed "sympathy," that occurs when two organ-pipes stand too near each other, require consideration from the designer of a piano-forte. The addition of a second string, far from destroying the vibrations of the first, or even interfering with them, more than doubles the power of the tone. A single string gives forth a comparatively insignificant and feeble note. When three strings are used, the third does not add half as much again, a fourth string adds still less in proportion, and, judging from the quality of the tone produced, seems to require an entirely new design.

In the final adjustments of the piano-forte by men of extremely keen sensibilities, certain defects, limitations, and peculiarities of the human ear, have been discovered that are noteworthy. The Greek architects well knew that long horizontal lines, if straight, would not appear to be straight when viewed from below, and therefore in the Parthenon they executed exceedingly delicate curves. Their columns were not exactly cylindrical, and many similar and most subtile deviations from geometrical truth were employed that remain as evidences of their consummate skill. In music, also, certain *nuances*—deviations from rigid accuracy or mathematical truth—are constantly made by which the powers of true artists are manifested. These minute shades of difference—these slight variations or modifications of quality of tone, power of tone, pitch, speed, etc.—when not exaggerated, but determined with an art-concealing art, are found to be true to Nature, and find their justification, not as exceptions to general rules, but as exemplifications of the highest principles. The refined perceptions of piano-forte finishers have led them to the fact that the highest notes of the instrument should be tuned slightly sharper than perfect, or each note will appear to be flat, when compared with the octave below. If these notes are tuned perfectly, and proved to be so by various tests, there still remain a secret dissatisfaction and conscious-

ness of a certain dullness, which detracts so much from the good effect of the instrument as to lead some persons to suppose it to be one of inferior quality. The expedient, therefore, of slightly raising the pitch of about seventeen of the highest notes (when the piano-forte is extended to high C) is adopted, by which the instruments gain greatly in brilliancy, briskness, sprightliness, or whatever term may fitly denote the reverse of flatness and insipidity. Octaves tuned in the middle of the key-board are frequently deemed perfect when too small, and some few students of tuning are prone to accept as true, octaves that are too large in this region of the scale.

But by far the most extraordinary fact, with reference to the final adjustment of the piano-forte, is the general acceptation of its particular "temperament" for all instruments having twelve notes to each octave. Whatever other temperament may be chosen for such instruments, only one simple, natural diatonic scale can be properly rendered. With this arrangement, called the "equal temperament," not a single chord is correctly tuned. No intervals are made absolutely perfect, but the ear has gradually been led to be content with them, when they approximate the truth in conformity with this particular system. By the equal distribution of the many kinds of *apotomes*, found on calculating intervals from the scale given by Nature's super-harmonics, they are subsequently practically disregarded—treated as non-existent—and thus elaborate modulatory harmonies are rendered comparatively easy to construct; and the human ear being less able to detect imperfections in dissonances than in consonances, composers have gradually employed, with increasing freedom, dissonances of the most unusual and startling kind. It would not be strictly true to say that modern writers have neglected the sweet, cloying style—abounding in pleasant-sounding phrases—because the absolute perfection of these ready-made, dissonant harmonies is more readily overlooked. The influences that have determined the course of modern art can only be perceived from a psychologic point of view. We may, however, safely say that modern composers have not been deterred, but rather assisted, if not actually emboldened, by their enharmonic intervals being made freely interchangeable, their far-fetched harmonies easily found and little scrutinized; and point out that the dynamic power of discords increases their present value as artistic materials, now that fugal and similar forms, compelling progress, are more rarely used.

The temperament of the piano-forte led directly to the entire remodeling of the "king of instruments," the church-organ; but yet, not without considerable strife. During the first three-quarters of the present century this particular form of temperament was a matter that greatly exercised mathematicians, organ-builders, musical purists, clergymen, and organists, in England, and has only now become generally adopted in that country. The solid and highly-com-

pound tones of the organ, sustained with equal energy, caused the imperfections of the concords to be markedly apparent. They could not be ignored, as when occurring with the evanescent tone of a piano-forte. The super-harmonics, or summation-tones, disagreeing with each other, developed, in common with difference-tones, a mass of attendant dissonances, which even the employment of a double foundation (sixteen-feet manual stops) and powerful pedal-organ, etc., could barely hide.

The music of the Church was then as calm and free from passion as the sculptures of Phidias; no exciting dissonances held the listener spellbound until they were resolved. The organ-builders, accordingly, produced instruments that were solemn, sedate, serious and grave, forcible and powerful, without betraying passion or the flutterings of private, personal emotion. To use this temperament would be to destroy these features, which the piano-forte-makers did not desire to retain. They sought brilliancy and contrast for secular requirements, and were at once manifestly gainers by the system; while the organ-builders were compelled to reflect very seriously on matters of ritual and their own reputations.

To make this clear: Let the length of a stretched string be represented by unity, and $\frac{1}{2}$ or $\frac{64}{128}$ the octave. Now, three major-thirds are less than an octave; for $\frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} = \frac{64}{125}$. Again, let $\frac{1}{2}$ or $\frac{648}{1296}$ represent the octave, and it will be seen that four minor-thirds are greater than an octave; for $\frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} = \frac{625}{1296}$.

The contraction of the minor-thirds, therefore, by one-fourth of the ratio 625 to 648, caused a further depression of the significant note in the minor-chord, by which it became more gloomy and depressed; and the expansion of the eloquent major-third by one-third of the diesis, or ratio of 125 to 128, caused the expression of joy in the major-chord to be exaggerated or intensified, or even over-excited, when compared with the peaceful, contented, restful character of the pure harmony.

These violent contrasts affected the quality of the tones, not individually, but when heard in combination. The general character of the tone-tint was thus greatly modified.

That the ear is much more sensitive to imperfections of intervals with simpler ratios is proved by the uneasiness experienced while a violinist tunes his strings to the interval of a fifth ($\frac{2}{3}$). Twelve such fifths exceed the octave by an interval having the ratio of 524.288 to 531.444. Each successive fifth must, therefore, be contracted one-twelfth of this interval (or *diaschisma*), that the series may be bounded by a perfect octave; and in this manner the tonal system of keys, which is in reality a slowly-ascending infinite spiral, practically takes the form of a circle. This fact must be borne in mind if one would satisfactorily account for many laws of art. The ideal purity which enraptures the creative artist is never realized; for all performances are marked by the imperfections attending human efforts.

That a general compromise, or sacrifice of truth to convenience, must be made in instruments having twelve fixed tones to the octave, will be seen by a comparison of three most closely-related diatonic scales, and their respective proportions:

					G.	A.	B.	C.	D.	E.	F-sharp.	G.	
					240	213½	192	180	160	144	128	120	
		C.	D.	E.	F.	G.	A.	B.	C.	D.	E.	F.	G.
		360	320	288	270	240	216	192	180	160	144	135	120
F.	G.	A.	B-flat.	C.	D.	E.	F.	G.	A.	B-flat.	C.	D.	E.	F.	G.
540	480	432	405	360	324	288	270	240	216	202½	180	162	144	135	120

It is clear to the meanest comprehension that the sound "D," the second note of the scale of "C," differs from "D," the sixth note of the scale of "F;" and also that the sound "A," the sixth note of the scale of "C," differs from "A," the second sound of the scale of "G;" and similarly, in the ratio of 80 to 81.[1] It is evident that any

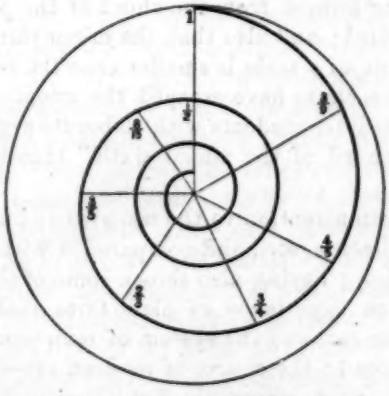
[1] The relative speeds of the vibrations of each note of the diatonic scale are here given for the convenience of persons accustomed to calculate by their aid.

264	297	330	352	396	440	495	528

The true diatonic scale may be represented in various ways, which may occasionally prove useful in measuring intervals, although the divisions are not exactly correct. Such as—

ASCENDING SCALE.	1. The Periphery of a Circle.	2. 53 Degrees.	3. 301 Degrees.	4. 730 Degrees.	5. In Mean Semitones.
C.....	33° 31″ 11′	10	56	136	1.1173
B.....	61 10 22	27	153	372	2.0891
A.....	54 43 16	16	92	222	1.8240
G.....	61 10 11	27	153	372	2.0891
F.....	33 31 11	10	56	136	1.1173
E.....	54 43 16	16	92	222	1.8240
D.....	61 10 22	27	153	372	2.0891
C.....	.....	..	...	...	.....
	360° 0″ 0′	53	301	730	12.0000

But the logarithms of the ratios of the intervals are most generally used. The logarithmic or equiangular spiral best illustrates to the eye the return of the octave, the curve



being so drawn that a complete revolution halves the distance from the pole. It is also valuable for other properties besides this geometric periodicity, representing a continuously-rising tone.

note, say "D" on the piano-forte, which has to do duty for all the various kinds of "D," as well as those of "C double-sharp" and "E double-flat," must be so attuned as to form a happy mean between them.

If, then, in the extremely simple case given above, drawn from the triune system of scales and chords, exemplified in the most insignificant compositions, one may be led to doubt and difficulty, it is easy to understand that violinists and others prefer to follow blind rules, leading them to make, for instance, all notes with sharps, higher than their enharmonic equivalents in flats, and *vice versa*, in elaborate compositions, that would involve calculations of extreme complexity; or, in such cases, to follow their own subjective feelings rather than seek justification by mathematical proofs, especially when performing alone their own parts, and thus not called upon to act in conformity with others. In such cases, notes depressed, and having a downward tendency, are more depressed; and notes raised, which are aspiring, are made more elevated. The interval C : G flat would therefore be contracted, and that of C : F sharp enlarged in the following (frequently-heard) expressions:

G-flat.....F.			F-sharp.....G.
C.....D-flat	and		C.....B.

The "C" in the first progression is also virtually a raised note, and the "C" in the second a depressed note, as may be seen by reference to the scales indicated by the terminating chords. The laws which musicians obey, consciously or unconsciously, in the ordinary routine of composition and performance, are very fascinating, and will ere long be systematized.

The three scales given above prove that the chord of A-minor, formed with two notes from the chord of C, differs in altitude from the chord of A-minor formed from the chord of the parallel A-major, by depressing the third; and also that the minor-third from the second to the fourth note of a scale is smaller than the remaining minor-thirds. These facts seem to have escaped the attention of all writers on harmony, who bewilder students with elaborate arguments respecting the so-called "chord of the added sixth," that undermine their own theories.

Having now drawn attention to the use of the piano-forte, its evolution, longevity, ailments, etc., and compared it with the violin with reference to its vitality; having also shown some of the singular facts that are the common experience of piano-forte makers and tuners respecting the human ear, and the system of temperament, which has not been a hinderance to the course of modern art—let us now consider that remarkable phenomenon, the "peculiarity of the key," which remains, or is acknowledged to remain, by most candid persons, even now that equal temperament is universal, and that the pitch has been gradually raised.

In the English translation of Bombet's "Life of Haydn" a list of the keys is given with their acknowledged characteristics appended. Thus: "D-flat major. Awfully dark. In this remote key Haydn and Beethoven have written their sublimest thoughts. They never enter it but for tragic purposes." Again · "A-flat major. The most lovely of the tribe. Unassuming, gentle, soft, delicate, and tender, having none of the pertness of A in sharps. Every author has been sensible of the charm of this key, and has reserved it for the expression of his most refined sentiments." And so on. Now, it was never supposed that the peculiarities of the keys could be confused with the peculiarities of the old modes, such as Dorian, Phrygian, etc., which led Dryden to say, "Softly sweet in Lydian measure;" for all these modes were designedly, mathematically, and markedly, dissimilar. But it was generally supposed that the "unequal temperament," which favored some keys at the expense of others, led to the various, otherwise unaccountable, characteristics. These, however, have remained, singularly enough, with the "equal temperament," by which system all the keys are equal—i. e., the ratios of their intervals are precisely similar.

This peculiarity of the key is not to be confounded with other, accountable differences: such as induce composers to write in flat keys for military bands to attain the greatest brilliancy, and in sharp keys for orchestras for the same end. In these cases the greater number of open notes (more naturally and simply formed tones), and other such known facts, lead to a clear understanding on this point. But in the piano-forte no such considerations can be made to account for the subtile phenomenon. It was once supposed that the absolute pitch employed was the cause of the difference; but since the time of Haydn the pitch in all countries has risen to such an extent that the scale of A-flat characterized above has become virtually the scale of A-natural, with which it was there compared; but no corresponding variation of opinion respecting it has been recorded. Ladies still commonly express a decided preference for flat keys, and probably for this reason fashionable drawing-room music is generally cast in four or five flats—although these keys may be also chosen partly because, according to the conformation of the hand and the disposition of the ivory keys, the chords with flats are more easily and readily controlled, especially when distributed in the arpeggio style, and have to be played with great speed, freedom, and facility. But the various attempts made to account satisfactorily for key-character on the piano-forte have hitherto only demonstrated that reason and understanding are incapable of fathoming and explaining the matter.

The piano-forte of the present day is, as we have seen, the result of many contributions. Posterity alone can pronounce judgment upon it, and show in what it is deficient; for who shall say what the "piano-

forte of the future" will be? We ourselves complacently regard our age and its works, while anticipating the constant progress of the human race and its increasing ability to "reveal itself in tones."

SNORING, AND HOW TO STOP IT.

By JOHN A. WYETH, M. D.

TO those unacquainted with the mysterious parlance of the anatomist, the use of strictly scientific terms might prove discouraging and fail to interest. I shall therefore discard the *scientific* in favor of the *every-day* phrases, in explanation of the following figure (1), which, it will be observed, represents a human head split from above downward through the central line.

Through the only two channels in which the air travels in going to the lungs, namely, through the nose and mouth, are drawn two arrows,

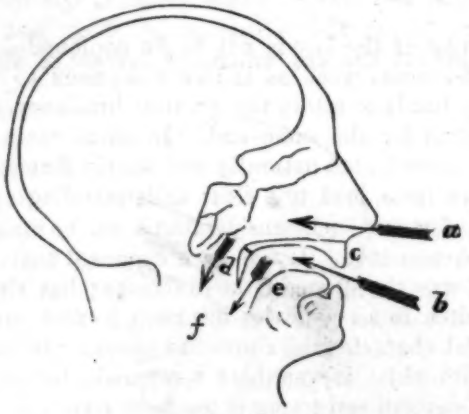


FIG. 1.

a and *b*. These two passages unite in a common cavity at *f*, and from that point there is but one tube leading to the lungs.

At *c* is a bone called the *hard palate*, which forms the roof of the mouth and the floor of the nose, separating these two air-channels from each other. At the inner or posterior end of the bone, *c*, is seen a little body, *d*, called the *soft palate*, made of muscle and covered with a delicate skin. This *soft palate* is attached at one end to *c*, the *hard palate;* the other end hangs loose, and moves or flaps in the act of breathing, something like a window-curtain when acted upon by a current of air. This is its condition while we are asleep or awake, though during sleep it lacks in *tonicity*, being much more relaxed, or flabby, than when we are awake. At *e* is represented the tongue.

Now, in order to snore, one must keep the mouth open, as well as the nose, and in this condition the two currents of air, *a* and *b*, passing in and out together during the acts of breathing, catch this little curtain, *d*, between them, and throw it into rapid vibration. This vibration, more or less intense and sonorous, is what we call *snoring*.

It is only with the mouth open that snoring can be accomplished during sleep. Awake, if the nose is closed by the thumb and finger, by taking a forcible breath, it is possible to snore, and the same result may be accomplished with the mouth shut and the nose open; but the muscular effort necessary to its accomplishment is more than we can command during sleep, and would wake up the individual who might unconsciously make the effort.

If the mouth be closed (the natural condition during slumber), but one current of air will pass to and from the lungs. This current, pressing about equally upon all sides of the canal indicated at *a*, will press the *soft palate*, *d*, forward and downward until it is applied to the tongue, *e*, and will hold it there gently, thus preventing any sonorous vibration.

It follows that any device which prevents the lower jaw from dropping down, during the relaxation of sleep, and opening the mouth, will shut out the one unnatural current of air and prevent snoring.

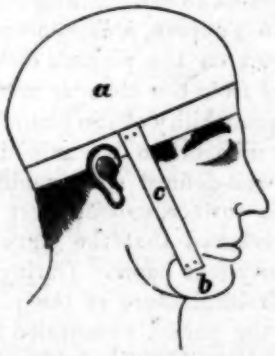


Fig 2.

I have devised the apparatus represented in Fig. 2, which consists of a simple cap, *a*, fitting the head snugly; a cap of soft material, *b*, fitting the chin; and a piece of elastic webbing, *c*, tacked to the chin-piece, and to the head-cap near the ears. The webbing can be made more or less tense as may be required to effect the closure of the mouth.

The apparatus is so simple that any one can make it; and the writer hopes this explanation will recommend itself to those individuals who, from the possession of this unfortunate habit, are a nuisance to everybody—excepting themselves.

MARS AND ITS SATELLITES.

By Professor DANIEL KIRKWOOD.

THE recent and wholly unexpected discovery of two Martial satellites has awakened a new and lively interest in all that relates to our neighboring planet. Its telescopic aspect and the probable nature of its physical constitution are especially worthy of renewed consideration.

The mean distance of Mars from the sun is 139,877,000 miles.[1] Its orbit deviates more from the circular form than that of any other principal planet with the exception of Mercury; its eccentricity being 0.09326. The difference, therefore, between its greatest and least distance amounts to about 27,000,000 miles. But the eccentricity, though great, is nevertheless increasing; and, when it shall have attained its superior limit, the aphelion distance will be 196,000,000 miles. This is greater than the perihelion distance of many asteroids. Mars, therefore, occasionally invades the cluster of minor planets. Is it not possible that his superior force may attach some of its members to his retinue of satellites?

Mars was the first planet to exhibit indications of an axial revolution. As early as 1636 Fontana, a Neapolitan astronomer, had an imperfect view of a spot on the planet's disk. He reobserved the same figure in 1638, and from the changes noticed in its position and aspect he inferred the probability of the planet's rotation. He seems, however, to have made no effort to determine its period. Dr. Hooke, in 1666, noticed some well-defined spots, which he found to change their appearance on the surface, to disappear and return at regular intervals; whence he inferred that the planet completes a rotation either in twelve or twenty-four hours. During the same year Cassini observed spots on each hemisphere of the planet, from the motions of which he concluded the period of rotation to be $24^h\ 40^m$. In 1704 Maraldi, the nephew and pupil of Cassini, made a series of observations on the spots, from which he deduced a period of $24^h\ 39^m$. In 1719 he renewed his observations under favorable circumstances, and obtained a period precisely equal to that originally found by Cassini. In order to determine the exact period of rotation, Sir William Herschel undertook a series of observations in 1777, which he again resumed in 1779. From the changes which he observed in the appearances of the planet he fixed the time of revolution at $24^h\ 39^m\ 21.67^s$. The determination by Kunowsky in 1821 gave $24^h\ 36^m\ 40^s$. The observations of Beer and Mädler in 1830 indicated a period of $24^h\ 37^m\ 10^s$. Their observations, however, in 1832, combined with

[1] This value corresponds to a solar parallax of 8.88″.

those of 1830, gave 24ʰ 37ᵐ 23.7ˢ. In regard to the exact period of rotation and the slight discrepancies between the results obtained by different observers, Prof. O. M. Mitchel remarks as follows:

"In 1839 Mädler reviewed Herschel's observations, whence his first results were deduced, and discovered that, after introducing the necessary reductions, the discrepancy of two minutes might be reduced to two seconds, by giving to Mars one more rotation on its axis, between the observations of 1777 and 1779, than Herschel had employed.

"By combining Mädler's observation, made at Berlin, 1830, September 14th, 12ʰ 30ᵐ, with one made at the Cincinnati Observatory, 1845, August 30th, 8ʰ 55ᵐ, making the corrections due to geocentric longitude, phase, and aberration, I find the period of rotation to be 24ʰ 37ᵐ 20.6ˢ, differing by only two seconds from Mädler's period as last corrected."[1]

Finally, Richard A. Proctor, Esq., by an exhaustive discussion of all the observations, has determined the period to be 24ʰ 37ᵐ 22.735ˢ.

The diameter of Mars is about 4,700 miles. Its surface is rather more than one-third that of the earth, while its volume is to that of our planet in the ratio of two to nine.

The persevering labors of Beer and Mädler proved beyond question that many of the lineaments observed in the aspect of this planet are permanent in their character, and not merely atmospheric. The same spots, with the same general outlines, and the same varieties of color, have been noticed at successive oppositions; not always, it is true, with precisely the same distinctness, but without any other changes than such as might be attributed to atmospheric variations. Two white circular spots are observed in the polar regions, which *increase* during the winter, and *decrease* in the summer, of each hemisphere respectively, and which may, therefore, be regarded as polar snows. These spots were noticed by Maraldi as early as 1716; their connection, however, with the change of seasons was first shown by Sir William Herschel. The same astronomer found the inclination of the axis of Mars to the plane of its orbit to be 61° 18′. The Martial tropics are therefore 28° 42′ from the equator, making the torrid zone 10° wider than that of the earth. In so far, then, as climatic changes are dependent on the obliquity of the planets, the seasons of Mars may not differ, perhaps, except in their duration, very greatly from our own.

The Satellites of Mars.—We come now to the history of one of the most interesting discoveries of the nineteenth century. With the single exception of our own moon, Mars is the most favorably situated of all the heavenly bodies for telescopic observation. The most careful scrutiny, however, for more than two centuries, had failed to furnish any indication of the existence of a satellite. The opposition of Mars in August, 1877, occurred when the planet was

[1] *Sidereal Messenger*, p. 101.

very near its perihelion. The body was, therefore, in the best possible position for close examination. At the approach of this favorable epoch the new twenty-six inch refractor of the Naval Observatory at Washington, under the skillful direction of Prof. Asaph Hall, was turned upon the planet. On the night of August 11th a small star was observed near the disk of Mars, but its true character was not then suspected, or at least not determined. On Thursday night, the 16th, at 11^h 42^m, Prof. Hall again noticed a star of the thirteenth or fourteenth magnitude, very close to Mars, and measured its apparent distance from the planet. On the same night, about two o'clock, he again examined the planet, and to his great surprise found that the small star had moved in company with Mars. *He had therefore discovered a Martial satellite.* On Friday morning the observations were submitted to Prof. Simon Newcomb, who, from the data furnished by a watch of five hours, calculated the time of revolution, which he fixed as a first approximation at 31 or 32 hours. This showed that the satellite must pass behind Mars some time during the following night. It was accordingly invisible when first looked for in the evening, but, as predicted by Newcomb, it reappeared about one o'clock. On Saturday morning the discovery was made known to Admiral Rodgers, the superintendent of the observatory. It was determined, however, to wait for another observation before formally announcing so important a discovery. On Saturday evening the satellite was again found very nearly in its predicted place, and its exact position was measured by several astronomers.

About four o'clock on the morning of August 18th Prof. Hall discovered a second satellite, interior to the orbit of the first, and of about the same apparent magnitude. The astronomers of Europe were officially notified of the facts by the following dispatch:

"WASHINGTON, *August* 18, 1877.

Two satellites of Mars have been discovered by Hall at Washington. First, elongation west, August 18th, eleven hours, Washington time. Distance, eighty seconds; period, thirty hours. Distance of second, fifty seconds.

"JOSEPH HENRY."

The statement of fifty seconds as the distance of the inner satellite was subsequently found to be quite erroneous.

On Monday, August 21st, Rear-Admiral Rodgers, superintendent of the observatory, communicated the discovery, together with Prof. Newcomb's approximate circular elements of the orbits, to the Hon. R. W. Thompson, Secretary of the Navy.

DISTANCES FROM THE CENTRE OF MARS.—The distance of the inner satellite from the centre of the primary is about 5,700 miles; that of the outer, 14,200. The distance of the former from the surface of Mars is but 3,300 miles—no greater, in fact, than that of London from New York. The apparent magnitude of Mars as seen from this satel-

lite is 2,000 times greater than that of the sun or moon as seen from the earth.

PERIODS OF THE SATELLITES.—Prof. Newcomb gives 30^h and 14^m as the period of the outer satellite, and 7^h and 38^m as that of the inner. Both move, like our moon, from west to east. The period of the inner is *less*, while that of the outer is *greater*, than a Martial day. It is obvious, therefore, that, as seen from the surface of the planet, the *apparent* motion of the satellites will be in opposite directions, the inner rising in the west and setting in the east; the outer rising in the east and setting in the west—so that the phenomenon of two moons meeting in mid-heaven will be to the Martialists no unusual occurrence.

THE MASS OF MARS.—Before the discovery of these satellites the determination of the mass of Mars was a problem of great difficulty, the body being too small to have much effect in disturbing the motions of other planets. The value assigned by Burckhardt was $\frac{1}{2680337}$, that of the sun being unity. The difficulty of the problem is now happily removed, and Newcomb has found from the elements of the exterior satellite a value of $\frac{1}{3093000}$; a mass less than Burckhardt's in the ratio of six to seven.

THE BEARING OF THE DISCOVERY ON THE NEBULAR HYPOTHESIS.—The inner satellite of Mars completes three orbital revolutions in less than a Martial day. This anomalous fact in the planetary system would seem, at first view, to be utterly inconsistent with the nebular hypothesis. The question is one of more than ordinary interest, but its discussion may well be deferred until we shall have obtained more exact information in regard to the Martial system.

HUXLEY'S AMERICAN LECTURES.

BY PROFESSOR E. RAY LANKESTER.

THE five addresses which have been recently brought out by Prof. Huxley in the form of a small volume were delivered under very varied conditions, and deal with subjects widely separate from one another. Three of them form a series of lectures on the doctrine of Evolution, and were delivered by the author at New York in September, last year. These were the only popular scientific lectures which Prof. Huxley would allow himself to undertake during his summer holiday devoted to a tour in the United States. The "Address on University Education" was delivered at the formal opening of the Johns Hopkins University, at Baltimore, during the same visit. The concluding lecture of the present volume was delivered in connection

with the Loan Collection of Scientific Apparatus at South Kensington in December, last year, and deals with the study of Biology.

The range of topics thus indicated is wide enough to give us samples of all the moods of Prof. Huxley's vigorous and eloquent style. As compared with his previously-published addresses and essays, we find no diminution of power, no less artistic care in the arrangement of materials, no less cogency of argument and stern insistence on the appeal to facts rather than to *a priori* considerations, nor can we detect any indication that as he grows older the author is more timid in face of those "logical consequences" of his teaching—the bugbears of some, but the beacons of other, philosophers. Perhaps—and this is more especially noticeable in the lectures on Evolution—there is less of that playful treatment of opponents and their transgressions—that sudden but graceful discomfiture of his adversary by the unexpected production of a quaint though close-fitting illustration—which in former writings gave a pungency and aroma to Prof. Huxley's pages no less fascinating than peculiarly their own.

In the three lectures on Evolution, the history of Nature is made the subject of a closely-reasoned inquiry. Three current hypotheses —the Uniformitarian, the Miltonic, and the Evolutional—are recognized, and their respective claims to our acceptance discussed. The paleontological evidence in favor of the hypothesis of Evolution forms the subject of the second and third lectures, and with great skill the opportunity is used in order to bring before an American audience in the most forcible way two very important and interesting American discoveries of recent date. America is, indeed, rapidly becoming the headquarters of paleontological research. Prof. Huxley's own discoveries regarding the genealogical connection of birds and reptiles form an important argument in favor of the hypothesis of Evolution, and in placing this argument before his audience he was able to explain to them at some length the interesting new fossil birds obtained by Prof. Marsh, of Yale College, from the cretaceous rocks of Western America. The structure of two of these birds, *Hesperornis* and *Icthyornis*, which possessed, unlike all other birds, distinct conical teeth imbedded in their jaws, is illustrated by woodcuts in the printed lecture. Now that the principle has been admitted, we may hope to see an illustrated edition of some of the lectures which were issued in preceding volumes without woodcuts.

The second American discovery which is brought to bear on the hypothesis of Evolution, and forms, indeed, part of what Prof. Huxley calls the "demonstrative evidence of Evolution," relates to the pedigree of the horse, and is also due to Prof. Marsh. Strangely enough, America, which within the historic period is remarkable for the absence of indigenous horses, and the fertility within her borders of the wild-horses descended from domesticated ancestors of the Old World, is even more remarkable for having buried in her soil a greater

number and variety of fossil horses than any that the Old World can show. *Eohippus* and *Orohippus* from the American Eocene deposits, and *Mesohippus* from the American Miocene deposits, are most important links in the series (the later members of which are *Pliohippus*, *Hipparion*, and *Anchitherium*, found also in European Tertiary strata), connecting the living one-toed genus Equus with a typically five-toed ancestor common to it and other ungulate mammals. The structure of the feet and teeth of this series of forms, which furnish demonstrative evidence of the evolution of the horse by progressive modification, is placed before the reader in its main features with great clearness, and the description is notably assisted by a full-page woodcut.

The choice of the term "Miltonic" in place of any other for what is sometimes termed the "Mosaic" account or hypothesis of creation, and the statement of the reasons which have led to that choice, are samples of a kind of serious jesting in which Prof. Huxley shows infinite skill and delicacy. There is no doubt, he urges, as to Milton's view of the history of creation, as given in his great poem. On the other hand, were a writer to call this the "Biblical doctrine," he "would be met by the authority of many eminent scholars, to say nothing of men of science, who at various times have absolutely denied that any such doctrine is to be found in Genesis." In fact, we are told by these authorities that the six days of Genesis are six periods that we may make just as long or as short as convenience requires. "A person," says Prof. Huxley, "who is not a Hebrew scholar can only stand aside and admire the marvelous flexibility of a language which admits of such diverse interpretations." The term "Mosaic," in reference to the same doctrine, Prof. Huxley also considers objectionable, because "we are now assured upon the authority of the highest critics, and even of dignitaries of the Church, that there is no evidence that Moses wrote the book of Genesis, or knew anything about it."

"You will understand," he says, "that I give no judgment—it would be an impertinence upon my part to volunteer even a suggestion—upon such a subject. But that being the state of opinion among scholars and the clergy, it is well for the unlearned in Hebrew lore, and for the laity, to avoid entangling themselves in such a vexed question. Happily, Milton leaves us no excuse for doubting what he means, and I shall therefore be safe in speaking of the opinion in question as the Miltonic hypothesis."

The Baltimore address gives us a sketch of the writer's ideal of primary education, of university education, and especially of medical education—how to encourage research, and how best to fill vacancies in a professoriate. He does *not* hold the view that "you can go into the market and buy research, and that supply will follow demand, as in the ordinary course of commerce." His conviction is that "the best investigators are usually those who have also the responsibilities of instruction." Very valuable for other universities than that of

Baltimore are Prof. Huxley's few words of advice on "buildings." "Get an honest bricklayer, and make him build you just such rooms as you really want, leaving ample space for extension." When

"you have endowed all the professors you need, and built all the laboratories that are wanted, and have the best museum and the finest library that can be imagined; then, if you have a few hundred thousand dollars you don't know what to do with, send for an architect, and tell him to put up a façade. If American is similar to English experience, any other course will probably lead you into having some stately structure, good for your architect's fame, but not in the least what you want."

The South Kensington lecture contains some strong pleading for the study of Biology, as a subject of deep importance to the community. Among other illustrations of its importance it is urged that thereby alone are men able to form something like a rational conception of what constitutes valuable criticism of the teachings of biologists. "Brilliant articles" are from time to time written by "paper-philosophers" devoid of even the elements of biological knowledge, and the teachings of biologists are demolished, while the weather-cock heads among us are, Prof. Huxley tells us, much exercised by the "winds of doctrine" let loose in the said articles. Turning, however, to his favorite storehouse of metaphor, he finds that the brilliancy of the writers "is like the light given out by the crackling of thorns under a pot, of which Solomon speaks." Solomon makes use of the image for purposes of comparison, but Prof. Huxley politely abstains from proceeding further into detail.

The study of Biology which is here advocated is practical study of the actual phenomena presented by plants and animals.

"Nobody will ever know anything about biology, except in a *dilettante* 'paper-philosopher' way, who contents himself with reading books on botany, zoölogy, and the like; and the reason of this is simple and easy to understand. It is that all language is merely symbolical of the things of which it treats; the more complicated the things, the more bare is the symbol, and the more its verbal definition requires to be supplemented by the information derived directly from the handling, and the seeing, and the touching, of the thing symbolized—that is really what is at the bottom of the whole matter. . . . You may read any quantity of books, and you may be almost as ignorant as you were at starting, if you don't have, at the back of your minds, the change for words in definite images which can only be acquired through the operation of your observing faculties on the phenomena of Nature."

The *rationale* of the demand for *practical* teaching in all branches of science—a demand to which it is exceedingly difficult to get those who have the direction of educational institutions in this country to accede—has never been stated with more simple force than in the above extract.

Like all his writings, this last volume by Prof. Huxley presents

him to us in the aspect of a sure-footed resolute guide who, with a firm hand, takes us up an endless variety of the peaks of social and scientific problems, hard to be scaled. He brings his reader skillfully up to the summit, explains the prospect, and carefully deposits him again in his proper place. There are few excursions, where a little exertion is needful, so exhilarating and profitable, so much to be recommended to the traveler among questions of the day, as those which are accessible through the good offices of Prof. Huxley.—*The Academy.*

SPECIMENS OF EDUCATIONAL LITERATURE.

By F. W. CLARKE.

AMERICA is unquestionably preëminent in educational matters. It has more schools and a greater variety of schools than any other country on the face of the earth. Some of these schools are extremely remarkable. You cannot match them elsewhere. They thrive only upon the freest soil, untrammeled by effete conventionalities. Throughout the West and South they spring up abundantly, as if in proportion to the fertility of the land. The New England and Middle States are too much tied down to routine and tradition to produce such rare developments of the intellect. Such schools deserve to be more widely known and more generally appreciated. We propose to help some of them to a broader fame, by printing a few extracts from their circulars and catalogues.

First in order let us take some clippings from a little pamphlet issued by a school in Faribault, Minnesota. This circular is remarkable for its clear expression of views upon a variety of educational topics, and for the suggestions it offers concerning real school discipline. Here are a few of the wise regulations:

"Scholars with any contagious trouble or disease are not allowed in the school till cleaned, or till their disease is beyond danger.

"If a snow-storm is up, the teacher takes the privilege to dismiss the school earlier in the afternoon than it otherwise would have been.

"It is not allowed to scholars to jump on to or hang to teams except on the way to or from school, and then only with the permission of the driver.

"Anything belonging to the school-house or to the scholars, broken, torn, or damaged, must be paid or restored by the scholar or scholars who have done it, as well as by those who were accessory to it.

"Where a punishment is in order it will be applied whether a scholar's parent or any visitors are present or not."

And so on for about twelve pages. The remarkably concise and exact wording of these valuable rules must attract the attention of every teacher. The circular closes with a four-page essay upon "The

Affairs of Education," from which a few slips may be culled. The author holds that it is very unwise to be "lenient, indulgent, unconcerned, or superficial, in school-keeping," and considers it extremely wrong to resort to "a false show of unmasticated, unprepared, unfit, and undigested accumulation of stuff and material, producing neither educational bone, or muscle, or nerve, and crammed in, drummed in, or infused, as with a funnel, in a hurry, or in the worry and flurry of an unquiet, unconcerted school."

Who, understanding this, can doubt it? Or who can doubt that the confidence of the pupils in the teacher "renders them more apt to conceive how much they are bound in gratitude to parents and teacher, and to get aware of the depth of the contrast and abyss of their real course and nature of action and that what it should be, and thus makes them more studious to be grateful and to advance their own interests as scholars?"

The teacher of this school, like most other Germans, believes in systematic thoroughness. "But," says he, "this does not mean that in the system that promotes perception, thorough thinking and reasoning, understanding, memory, self-reliance, deceitless ennobling enlightenment, and well-digesting progress, a scholar gets along slowly over the ground or through the books; on the contrary, while it excludes headway on the skip and jump, as each point is completely learned and mastered, it makes the next depending on this so much easier and more quickly grasped, and in a short time, what puzzles and discourages others, becomes to him the greatest delight; and thus he progresses from point to point, from page to page, from combining to combining the known with the unknown, the former unlocking and explaining the latter, and so he moves faster and faster, leaving the half-tutored, unsteady fustians far back in the distance."

The last citation which I shall make from this document might be construed into a rap at myself:

"It would be malicious folly without self-respect, to detach parts of this circular from their dependent connection with others that explain their spirit and application, and then to pervert their true construction; hence it is not intended for such persons," etc.

On second thoughts, however, this passage can refer only to those who have criticised the school and made light of its methods. "Let the galled jade wince, our withers are unwrung." We can only express our admiration for such an extraordinary "well of English undefiled," and for the profundity of the ideas contained in it.

Another school of peculiar interest is the Mars Hill Academy, near Florence, Alabama. The "permanent circular" of this institution, now before me, bears date 1872, and contains many points worthy of quotation. The merits of the school are well emphasized by the following paragraph:

"J. M. Cunningham, of Hamburg, Tennessee, boarded *one son and two daughters* at the Institution during the first session. During the second session he boarded *one son and four daughters* there. He seemed to regret his inability to do more for the school, but considered *little Emma, the baby*, rather too small to send to a boarding-school. He thinks, however, that the school is a good one, and deems it the duty of those who are blessed with more children than himself, *to lend a more helping hand. He is a man whose judgement and patronage are both valuable.*"

This remarkably italicized passage shows at once that Mars Hill Academy believes in the coeducation of the sexes. In another portion of the circular, however, we learn that, although the boys and girls are frequently brought into the presence of each other, the strictest care is taken "that all observe a proper distance." Furthermore, every pupil signs an elaborate pledge never to "seek or accept a private or secret conversation or correspondence with any pupil of the opposite sex from my own, and that I will never receive a proposition for such correspondence or conversation, or anything tending thereto, without immediately committing the same to the principal," and so forth, and so forth, and so on. Thus we see that coeducation, at least in this school, can hardly be considered dangerous. The morality of the scholars is also advanced by a Scriptural exercise of an hour in length every morning before breakfast. Here is a part of the result:

"At our last examination we examined the Bible class before the public for *one hour* without one unsatisfactory answer being given, and might have continued the examination with honor to all the members for *four hours*. They could tell with ease the number of *books* in the old Bible; the numer of *books* in the New Testament; the number of *chapters* in each; the number of chapters written by various writers; the name and order of *every book in the entire Bible;* the number of chapters in every book in the entire Bible; the *origin* and *meaning* of the names of the books; the *history of the creation* in detail; the history of the *first family;* the history of the *flood;* the history of Abraham, Isaac, Jacob, the twelve patriarchs, etc.; the history of the Egyptian bondage and deliverance; the number and order of the plagues of Egypt; the history of Sodom and Gomorrah; the beautiful, thrilling, story of the Cross, etc."

But the crowning glory of the school is to be found in the certificate given to every student at the end of his or her course. It is described thus:

"To every pupil, great and small, will be presented a VERY ELEGANT CERTIFICATE, containing a concise statement of the progress of the pupil, with the name, State, county, and post-office, of the same. These certificates are very beautiful; they are beautifully printed in *four colors*. In the centre is a representation of the earth, showing the equator, tropics, and polar circles. Around the horizon of the northern hemisphere is printed in green, 'Blessed are they that do His commandments, that they may have right to the tree of life, and may enter in through the gates into the city.' The southern hemisphere is bounded by—'Fear God, and keep His commandments, for this is the whole

duty of man.' Within this circle is beautifully arranged the following certificate:

"'This is to certify that M——, of —— county, ——, a good, kind, obedient, moral, studious, courteous, worthy, and honorable pupil of Mars Hill Academy, near Florence, Alabama, has attained a high degree of proficiency in ———, and is hereby recommended to the public as eminently worthy the confidence and esteem of every member of any community in which h— lot may e'er be cast, if future life does not corrupt h—.'

"This is surrounded by four hearts, two in red and two in green, and *eight beautiful, appropriate illustrations.* The words *Faith*, *Hope*, *Charity*, and *Heaven*, are printed in green and red within the hearts, in *Greek*, *Latin*, and *English*. Surrounding the heart on the north is the motto, 'Labor conquers all things,' in three languages. The name of the Institution on the south in three languages. In large and beautiful variegated characters the name and location of the Institution appear on the top and bottom of the certificate. All the space not otherwise filled is occupied by most beautiful and appropriate passages of Scripture. The whole is surrounded by a neat border, ends with the benediction of the Principal, and will be presented to each and every pupil, *elegantly framed*, so that it may be worthy of a conspicuous place in the most fashionable parlor. Size of frame, sixteen by eighteen inches."

Who, after reading this, does not long to possess just such a certificate?

All things considered, the most remarkable specimen of educational literature yet issued is the catalogue of Neophogen College, at Gallatin, Tennessee. This catalogue has no rival: it can never be excelled, and probably will never be equaled. It begins with a map of Sumner County, wherein the college is situated. Then come four woodcuts representing "honor-students," young gentlemen, a likeness of the college-president, John M. Walton, LL. D., and then four more effigies of "honor-students," young ladies. These woodcuts are unique. The next feature of interest in this pamphlet is the page devoted to the Faculty. Here the predominating name is Walton; it occurs no less than five times, although apparently but three individual Waltons are indicated. There are also a number of blanks indicating vacant professorships, not waiting, of course, for endowments, but for men of sufficient ability to fill them. Among these blanks we find the title of "Professor and Master, School of Phrenology, Physiognomy, and Hygiene." What a pity that so important a chair should be empty! But we find some compensation for this misfortune when we see near the bottom of the list the name of an estimable lady inserted as "Mistress of Cuisine and Hygiene."

After a long (and to the general reader uninteresting) list of students, with their marks for "application," "punctuality," and "deportment" appended, we come to a few pages of text. Here we learn much of the character and position of Neophogen. We are informed, for example, that it is a "National University," being "centrally located between the North and the South, the East and

PRESIDENT OF NEOPHOGEN COLLEGE.—(*From the Catalogue.*)

the West." Besides, "it is within a few hours' ride of Epperson, Red, Castalian, or Tyree Springs. Any kind of mineral water can be had at the College, if desired."

But piecemeal quoting is useless; we need a longer sample of this descriptive part of the catalogue. Let us take a page at once, with all its headings:

"THE TWO CUMBERLANDS,

with banks and crests adorned by the noblest monarchs of the forest, and embracing the lovely valley between, make the land of the poet's dream and the home of the artist's heart.

"HEALTH AND WEALTH

are here combined with 8,500 citizens, who cannot be surpassed for intelligence and refinement.

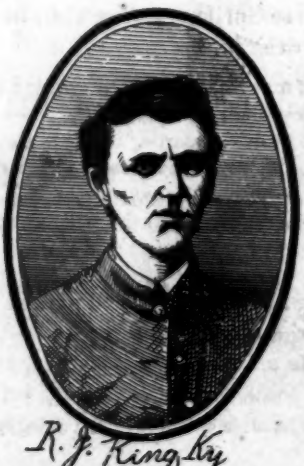
"NO PARALLEL

can be found (estimating the population) to the ten first-class turnpikes leading into this little city of enterprise. These fine roads are valuable auxiliaries to

A. W. Culbank. Ky.

Clara K. Williams Miami.

Rachel V. Cook Ark.



R. J. King, Ky.

HONOR-STUDENTS OF NEOPHOGEN COLLEGE.—(*From the Catalogue.*)

the school, for they can be made to contribute to the health and pleasure of both the students and the faculty.

"THE SCENERY

is most beautiful and romantic. In a single glance, from a central point, the eye surveys an ellipse, the circumference of which is 150 miles; and 'outstretching in loveliness'—the lawn, the woodland, the meadow, the town spread out beneath, the gushing rills, the flowing rivers, the farm-houses scattered here and there, the rugged cliffs—all make up a landscape which is at once picturesque and sublime. The future home of Neophogen was not selected without canvassing the advantages and inducements offered at all the most noted points in our country.

"THE COMMUNITY.

We claim for the citizens of Gallatin and vicinity that true virtue and magnanimity found alone in the most refined society.

"Here, identity is lost in public spirit. Here, a studious observance of the rights of others is ever manifested. Here, the principles fostered by those noble old pioneers are infused into the minds of their successors.

"Here are the descendants of those worthy spirits—the Winchesters, Trousdales, Jacksons, Peytons, Wynnes, Halls, Guilds, Turners, Barrys, Heads, Blackmores, Lauderdales, Bledsoes, Babers, Allens, Bennets, Blounts, Elliotts, Odoms, Dismukes, Blythes, Millers, Donelsons, Williamses, Boyerses, Bates, Montgomerys, Smiths, Duffys, Boddies, Glovers, Alexanders, Waltons, Kirkpatricks, Deshas, Blues, Winstons, Tomkinses, Houses, Hallums, Rascoes, Bakers, Greens, Stuarts, Wilsons, Wallaces, Moores, Joyners, Buggs, Franklins, Cantrells, Looneys, Hassells, Harrises, Malones, Pattersons, Parkers, Kings, Johnsons, Shutes, Guthries, Cottons, Branhams, Douglases, Bells, Tyrees, Martins, McCoins, Harts, Cages, with many other names worthy of emulation, and the half is not told.

"While we studiously ignore the idea of aristocracy and nobility, our minds are pleasantly associated with dignity and purity."

All this information is evidently just what a careful parent would require. The healthiness of a college town, and the character of its people, must be important to every father having a child to educate. As for the qualifications of the professors, the following passage is sufficiently suggestive:

"What is the duty of many, is generally neglected by all. Here is *continued* and *special* stimulus to president and professors; here are no easy and assured positions, with fixed and positive salaries, but they depend upon the patronage, prosperity, and reputation of the institution. That this should be so, is too obvious for comment. A very little knowledge of human nature is necessary to see why. To each teacher it is plain, the greater the labor, the greater the reward."

This passage is also instructive: "Learned men who have failed in business are tendered every inducement to take a life-home here. We intend to take the most active measures, and use every exertion, to raise a large life-fund for the relief of unfortunate literary men. Let them have homes, and the society of congenial spirits."

After the "curriculum," in which many studies are laid down with numerous text-books for each, comes a list of optional studies, with the extra prices affixed. Here we find "music on harp" quoted at $30, and "comparative philology" at $7.50. Italian, French, Spanish, and German, are ten dollars each; so that comparative philology may be regarded as given at a wholesale price. Languages are so much cheaper in a bunch than they are singly.

But the degrees given at Neophogen afford one of the most interesting items concerning the college. They are eighteen or twenty in number, and among them some are of considerable novelty. For example:

"A. M. will be given to any male, and M. A. to any female, who, after having received A. B., shall also graduate in penmanship and book-keeping, phonography and mnemotechny, comparative philology, and Anglo-Saxon, and in French, or German, or Spanish; and to a B. S., completing these same (preceding) additional or extra studies, the degree of M. S. (Master or Mistress of Science).

"M. E. L. (Master or Mistress of English Language), to any student graduating in the schools of humanities, and of history and moral science; and in common-school written arithmetic, elementary algebra, geometry, and the trigonometries and mensuration; in political economy and metaphysics; in penmanship and book-keeping, phonography and mnemonics, comparative philology and Anglo-Saxon.

"B. A. LL. (Bachelor (or Maid) of Ancient Languages).

"B. M. LL. (Bachelor (or Maid) of Modern Languages).

"B. M. (Bachelor (or Maid) of Music), to any graduate in music.

"B. M. and D., in Music and Drawing.

"B. M. and D. and P., in Music and Drawing, and Painting.

"B. F. A. (Bachelor (or Maid) of Fine Arts), to graduate in the three preceding, and also in wax-work."

But mere quotations cannot do full justice to this extraordinary catalogue. I will, therefore, give only a very few more, quite hurriedly, and leave the reader to seek for fuller details in the original document. Under the head of "specialties" a variety of studies are given, English, elocution, oratory, and typography, being made especially prominent. As for etiquette, this passage will speak for itself:

"It is not a matter of choice, but compulsion. The course of training in etiquette is, in great part, original. It has been said that manners make the man; if not true, they at least cannot be neglected. Here it is the theory with continued practice. We think we have the politest students in America. The salutation, the bow, the courtesy, the word, the tone, the look, the inflection—vocal and physical; the attitude, the hand, the feet, the spine, and the eye, are all observed and studied, and the students daily exercised in them."

Another passage of striking merit runs as follows:

"What has brought discredit upon diplomas of this age? What so greatly reduced the respectability of the word graduate in this age of nostrums and charlatanry? *Answer.* Silly parents, and incompetent and unscrupulous teachers.

"Parents that are content to purchase the labeled casket without the jewels; parents that are in many cases deceived themselves, and in other cases willing to deceive. Some reason thus: 'I have children, my children must be graduates, it is respectable.' Crœsus speaks, or intimates unmistakably, and it is done. There must be radical reform here. Common, old-fashioned honesty demands it. It must not be. The vital interests of our country cry aloud against it.

"We must steer aloof from making these pinchbeck and galvanized scholars. This will be very pleasant to the eyes of all honest, earnest, and competent teachers. We are all presidents and professors these days; but we have an uncontrollable fancy for those noble old words, 'teacher' and 'school.'"

The social importance of coeducation is shown thus:

"The young ladies and gentlemen are permitted, we may say required, to have interviews in the drawing-rooms twice in each month. The refining, elevating, and stimulating effects of these evening associations, regulated by system and class rotation, must be seen to be appreciated."

The moment we consider that the young ladies wear "green-calico dresses and white aprons" for a school-uniform, we cannot doubt the impressiveness of these interviews. Further on we find that prizes are given at Neophogen for "neatness," "grace," "true modesty," and "etiquette;" and the names of the "fortunate winners" are appended. The catalogue closes with two pages of "opinions of the press." A single specimen will do to illustrate these:

"The teachers of Neophogen College have the highest national reputation, both as teachers and authors. It is the cheapest college of the kind in the world, and is the best one for the males and females of the North and the South. It is located in a beautiful section of the State, which was selected with great care."—*Republican Banner (Nashville, Tenn.)*

These extracts sufficiently indicate the remarkable character of Neophogen. Who, after reading them, can longer doubt that the South is in earnest in this great matter of education? Let the boastful educators of New England bow their heads, and humbly confess that they can never hope to parallel such schools as the Mars Hill Academy and Neophogen College!

THE PSYCHO-PHYSIOLOGICAL SCIENCES.

By JOSEPH RODES BUCHANAN, M. D.

THERE has ever been, and probably for another century there will continue to be, an "irrepressible conflict" between those whose conceptions of Nature are limited by sensation—who recognize no existence but matter and motion, who trace all that exists to material causes alone—and a very different class of thinkers, who trace

causation beyond matter, who discover causes that are not material (called spiritual), who believe that the Great First Cause (the Unknowable of materialists) is an infinite spiritual power or basis of all things, and who recognize in man also a spiritual power of which they are conscious, widely different from matter, partaking of the nature of the Divine, and, being a very positive entity—the greatest of all realities to us—destined, in accordance with the doctrine of the persistence of force, to a duration analogous to that of matter.

To the materialist, who finds in matter "the promise and potency" of all things, there is no higher object of reverence and love than the examples of men and women within his reach; there is no future life to compensate for the wrongs and sufferings of this, the triumph of fraud, or the unmerited agonies of disease and poverty; there is no apparent controlling purpose of benevolence or justice in the universe, but only a chance medley of strife, in which strong-handed selfishness is best rewarded, and when "man dies as the dog dies" the account is closed, and the self-imposed martyrdom of the loving hero appears a final loss and folly.

To the spiritualist, the universe has a deeper meaning, a nobler destiny. The wisdom of the Infinite, which is unutterably beyond his reach, is a consoling reality, and the little play upon this theatre, the life-struggle of threescore and ten years, is but the beginning, the gestation and birth of a career corresponding to our noblest aspirations and our faith in the Divine benevolence.

Man has such immeasurable powers of adaptation that a strong moral nature may exist under the gloomiest views of materialism (which naturally tend to the pessimism of Schopenhauer and Hartmann), and sustain itself by its constitutional energy and buoyancy; but there are millions to whom materialism teaches the daily lesson that to "put money in thy purse" is the chief aim of life, and to riot in sensual pleasure on ill-gotten gain, until the candle burns out, is the best wisdom.

The glow of hope, the removal of anxiety, the exaltation of happiness, the enlargement of sympathy and love, which thousands have experienced when they have passed from the dark nescience of materialism to the brilliant certainties of spiritualism, and learned the grandeur of human destiny—whether the change has been effected by emotional eloquence and historical argument in the bosom of the Church, or by scientific investigation and experimental inquiry in pneumatology, or by that direct perception of spiritual existence now enjoyed by a few (and destined to be enjoyed by all when the human race shall have attained maturity of development)—should satisfy any impartial thinker that the diffusion of spiritual knowledge is as noble and practical a form of philanthropy as a good man can labor for.

But, in laboring for these ennobling truths, he encounters a strong resistance in the animal nature of man, in the selfish and depressing

character of our daily toils, and in the too great concentration of attention upon physical sciences, to the *exclusion* of those in which a psychic element is found. The study of physical science alone is no better preparation for psychic studies, which employ different faculties, than the study of the counting-house ledger or the supervision of a pork-house would be for the service of Parnassus.

A recent publication from Dr. Carpenter, embodying two lectures on psychic subjects (mesmerism, spiritualism, etc.), presents, in the most offensively exaggerated form, the pragmatic pretension of certain *physical* scientists to take charge of *psychic* investigations with an air of more than papal infallibility, and an emphatic notice to all the rest of mankind, not only that they are incapable of such investigations, but that their opinions, their testimony, and even their oaths are not entitled to claim a feather's weight before the self-created tribunal of which Dr. Carpenter is the authoritative mouth-piece.

The magniloquent insolence of such a proclamation would be amusing enough, even if Dr. Carpenter were, as he fancies himself, an expert of great skill; but when he is dealing with a subject of which he knows far less than thousands of the most enlightened people, far less than many men of science who are his peers in intelligence and his superiors in candor and in philosophic habits of thought, his insolent assumptions of superiority and denial of their claims to veracity and intelligence, whenever in conflict with his own theories, are all that his most unfriendly opponent could desire in order to demonstrate his utter unfitness for the task which he has assumed.

Passing by his ludicrous claims to a boundless superiority over contemporary scientists who do not follow his lead, we may ask whether he has any claims whatever to be recognized as an expert, whose opinions on these subjects have any especial value. Eminence as a physiologist does not imply eminence or capacity as a psychologist. It is true, physiology and psychology are coterminous sciences; but until recently their cultivators have kept as wide apart as the antipodes. Psychology has been prosecuted as if man never had a body (and ultra-psychologists do not admit that there is a human body or any other material existence whatever), while physiology has been cultivated in the same ultra spirit of nescience, as if man had no soul. So thoroughly does a feeble or a narrow mind, in fixing its attention on one object, lose sight of everything else. Dr. Carpenter himself has expressly excluded the soul from the pale of science, which is the next thing to excluding it from cognition, and one of the most recent voluminous and learned American works on physiology excludes it entirely, and substitutes the physical action of the brain, as follows: "The brain is not, strictly speaking, the organ of the mind, for this statement would imply that the mind exists as a force, independently of the brain; but the mind is produced by the brain-substance" (Flint's "Physiology of Man," Nervous System, p. 327).

Thus physiologists generally regard mind as purely phenomenal—as something holding the same relation to the brain as music to the violin, when the violin plays itself. If the relations of the brain to paralysis or to digestion are under consideration, such physiologists may be recognized as experts; but when its relations to a soul of which they know nothing are under consideration, we may very properly say to them, "*Ne sutor ultra crepidam.*"

Of course, materialists cannot deny that mental *phenomena* exist, but to them they are simply the phenomena of matter. Dr. Carpenter may even admit the existence of a soul beyond the pale of science—a quiddity as distinct from the real soul as Spencer's "Unknowable" is from any conception of a God. Practically speaking, Dr. Carpenter is entirely in harmony with other materialists.

Men of scientific culture, who have spent a considerable portion of their lives in practical investigation and familiarity with the facts of mesmerism, spiritualism, and other psycho-physiological sciences, are experts in the highest sense of that term, and can but smile at the insolence of those who, never having made a successful experiment on those joint operations of the soul and body which constitute mesmeric, spiritual, and other sciences, nevertheless claim, as Dr. Carpenter does, to be recognized as *the oracle* in matters of which his ignorance is both pitiable and ludicrous, having never, by his own confession, witnessed any of the innumerable facts demonstrating an extra-material agency, which, during the whole of the present century, have been accumulated and diffused in all civilized countries, and among their foremost thinkers. His position is precisely that of the principal Professor of Philosophy at Padua, who refused to look through Galileo's telescope, and continued to teach the old theories. Nay, far worse: he not only refuses to see what is open to all men, but, as Horkey wrote against Galileo, while refusing all fair investigation, and thus furnished an example to "point a moral" for posterity—an example of the power of "dominant ideas" in a bigot—Dr. Carpenter repeats the same performance amid the higher enlightenment of the present age, with a perversity and hostility of purpose which were never surpassed by the blind votaries of Aristotle. And as Horkey detected the trick in Galileo's telescope which made stars by reflected light, Dr. Carpenter too detects fallacies in the experiments of Prof. Crookes, whose temperate and candid reply places him in even a worse position than that of Martin Horkey. (See *Nineteenth Century* for July.)

In a question of the existence of certain facts, the honest witness who, without prepossession, investigates and follows up the facts wherever they are visible, is competent to instruct us; but he who carefully avoids coming into close contact with the facts, and, while maintaining his mind in undisturbed ignorance, feasts upon second-hand gossip and stale calumnies, which he retails with delight, is hardly entitled even to a nod of recognition among honest inquirers.

When Home was in England, and gentlemen of unimpeachable veracity and superior intelligence saw him lifted from the floor by an entirely invisible power, why would not Dr. Carpenter witness such an occurrence? When Slade was in England, of whom gentlemen of intelligence say that when a pencil was placed between two clean slates fastened together, which were left in full view of spectators in broad daylight lying on the table, messages were written on the inside of the slates, of a highly intelligent and appropriate character, why did Dr. Carpenter, if he possessed the sentiments of honor and love of truth which mankind generally recognize as commendable, refuse to make the simple and brief investigation which would have determined in an hour whether his theories and his stale calumnies had any foundation or not?

The truth is, Dr. Carpenter and men of his character care mainly for their own personal infallibility: they seek only the vindication of their own theories, *per fas et nefas*, and do not approach an experimental test unless they are permitted to interfere and dictate some method of conducting experiments to hinder or delay their progress. But when a simple experiment is proposed which cannot be intermeddled with, and which is completely and forever decisive, such as the levitation of a table or a man to the ceiling, no one being in contact with the lifted object, or the production of writing upon the interior of two clean slates which the inquirer brings himself, firmly secured together, the pretentious dogmatist is very careful to keep out of reach, no matter how he may be importuned or challenged. He generally fortifies himself with a few contemptuous phrases and a determination to see nothing of the marvelous.

The public that employs and patronizes men of science has a right to expect from them fidelity to truth and vigilance in seeking it—not cunning in evading or skill in calumniating true discoveries, followed by contemptuous neglect when their claims have been demonstrated. Such is the course pursued by some toward all discoveries in which psychic powers are involved. There is a fossilized materialism in many minds, which has become a matter of blind feeling, utterly irrespective of facts or science, against which it is vain either to reason or to offer facts. In the last resort the skeptic declares, "I wouldn't believe it if I saw it myself."

Of this vicious state of feeling, producing an incapacity to reason correctly on certain subjects, we need no better example than Dr. Carpenter himself, as exhibited in this *brochure* of one hundred and fifty-eight pages, the substance of which may be condensed into four propositions:

1. History exhibits a great deal of folly, superstition, and ignorance, and a great many preposterous narratives of witchcraft and silly miracles, attested by many witnesses: *therefore*, in the present enlightened age, human testimony is of no value when it affirms any-

thing out of the usual course of Nature (as observed by Dr. Carpenter), and the scientific testimony of Profs. Crookes and Wallace (reënforced by that of eminent men and women in Great Britain, France, Germany, Spain, Italy, and the United States, whose numbers and moral and intellectual capacity would outweigh any Royal Society or French Institute), is of no more value than the most fanciful mediæval legends of Catholic saints, which science does not condescend to notice.

2. Some individuals can be brought by a proper operator into a waking mesmeric condition of passive credulity and obedience to the voice: *therefore* we should believe *everybody* liable to this condition, and believe nothing that anybody tells us which is different from the usual course of Nature, *as Dr. Carpenter understands it.*

3. The usual course of Nature under our own observation—we beg pardon, *Dr. Carpenter's* observation—*is all of which Nature is capable*, and no new laws or agencies which Dr. Carpenter does not know are to be expected or developed by investigation. Whoever asserts that any such laws or agencies exist, is to be regarded as a liar or a victim of hallucination; and, in fact, the chief phenomena of mesmerism and spiritualism have been discovered to be cheats.

4. Mesmer advanced certain preposterous and unscientific pretensions; certain mesmeric operators have made failures; and Dr. Carpenter affirms that he has several times failed to discover any clairvoyance in celebrated clairvoyants, and has detected some pretenders to clairvoyance as impostors: therefore, mesmerism is a delusion.

It is difficult to treat such a mass of absurdity and misstatement with the gravity and courtesy appropriate to scientific discussion. When a dogmatic adult insists on proving to us that the earth is entirely flat, he takes rank, as a first-class bore, with Dr. Carpenter; and the only method of disposing effectively of such nuisances is that adopted by Mr. Alfred R. Wallace—a heavy wager to be settled by actual measurement of a portion of the earth's surface. If Dr. Carpenter had courage enough to endure the wager-test, he too might receive his *quietus* from Mr. Wallace. But there is no hope of that; the large reward offered in England, to any one who will produce certain spiritual phenomena by physical means, will never be called for.

The first proposition may pass for what it is worth. If there are any who agree with Dr. Carpenter in his assumption that the superstitious tales of an ignorant age are as worthy of credence as the elaborate investigations of the most distinguished scientists—men whose testimony would be decisive in any court of justice where life was at stake—it is not worth while to reason with *them*. The assumption of Dr. Carpenter is slanderous against his distinguished scientific opponents; but its extreme silliness renders it entirely harmless to any but himself. The same argument would destroy the credibility of medical, surgical, and physiological works of to-day, because

the medical records of former times contain much that is absurd and incredible.

The second proposition is but little better than the first. There is an unfortunate development of brain which makes or marks the constitutional and *incurable* bigot, to whom bigotry is philosophy. The Italian philosophers who denounced Galileo, and the French physicians who laughed at Harvey, were as unsuspicious of their own mental defects as Dr. Carpenter. Could anything but the blinding impulse of bigotry induce a man of great intelligence, age, and experience, to confound possibility with certainty in this ridiculous manner — to affirm that because certain individuals can be mesmerized in the American manner, wide awake, but passive creatures of the operator's voice, therefore we should consider *all men* liable to this condition, and treat all testimony that contravenes our *opinions* of the course of Nature as the testimony of helpless mesmeric subjects? By an exact parity of reasoning we may say certain individuals in every community have committed, or might commit, murder: therefore, whenever we find any one dead, and do not know how he died, we may assume that the men or women who were in his vicinity murdered him.

But suppose Dr. Carpenter should witness a case of levitation, and have the honesty to report what he saw, shall we then hold him to be either a mesmerized dupe or a confederate knave—which would he prefer to be called? Dr. Carpenter *may be* sincere, but he speaks quite reverentially of the Scriptures, although by his own declarations he must regard their miracles as shams which had never been exposed by a learned expert; and their spiritual phenomena, so analogous to those of the present day, as base impostures.

The third proposition, considered as a work of art, is an ingenious compound of evil, on which his satanic majesty might smile in grim approbation. Dr. Carpenter's language is as follows: "My contention is, that where apparent departures from them [the laws of Nature] take place through human instrumentality, we are justified in assuming in the first instance either *fraudulent* deception, or unintentional *self*-deception, or both combined—until the absence of either shall have been proved by every conceivable test that the sagacity of skeptical experts can devise."

As for himself, he affirms that he has "no other theory to support than that of the well-ascertained laws of Nature;" and further, that "it is quite legitimate for the inquirer to enter upon this study with that 'prepossession' in favor of the ascertained and universally-admitted laws of Nature which believers in spiritualism make it a reproach against men of science that they entertain."

If this be a true and honest statement of the case, there is no case in court for discussion: Dr. Carpenter is a philosopher, and the spiritualists are hopeless fools. By what muddled process of thought he could bring himself to make such a statement, we need not inquire.

There is not a scientific spiritualist who would not repudiate the statement as calumnious. If the laws of Nature can be violated, there is no absurdity or chimera which is not admissible; but, instead of believing this possible, spiritualists are the foremost of all men in insisting on the universal inviolability of all the laws of Nature, extending their infrangible power not only over all physical phenomena, but throughout the equally extensive psychic realm (in spite of all metaphysical speculations to the contrary)—an extension which Dr. Carpenter has not affirmed himself.

Dr. Carpenter *presumes* that liberal thinkers must be at war with the laws of Nature, because *he thinks* those laws incompatible with the new phenomena. The obfuscation of his mind is the same which has characterized narrow-minded bigots in all ages. The narrow-minded man cannot conceive two widely-different truths at once, and perceive their harmonies: he adopts one with zeal, and rejects the other firmly, because he thinks them incompatible. Narrow-minded men are of course bitter partisans, and the great majority of mankind from defective brains and irrational education see only one aspect of truth, and reject all others.

Dr. Carpenter sees no truth in mesmerism, and Baron Dupotet sees no reliable truth in medicine; Hahnemann rejected the entire accumulations of allopathy, and the old school indignantly rejected Hahnemann's discoveries as nonentities. A doctor who administers three-grain pills will not tolerate homœopathic pellets; and he who has discovered that infinitesimals will cure is often equally intolerant of the three-grain pills: and so they call each other quacks and impostors, in the same spirit in which Dr. Carpenter assails those who see more of the truth than himself, and are equally interested in psychic and physical facts. How long shall it be before the "survival of the fittest," or the improvement of education, shall give us a generation with brains enough to entertain two ideas at once?

The difficulty of Dr. Carpenter and all other narrow-minded people lies in the poverty of their conceptions. They have no idea that it is possible for Nature to show her powers in any new way to which they are unaccustomed. Hence, the ascent of a balloon seemed miraculous to the ignorant peasants, who took it for the work of the devil; and the formation of a solid block of ice from water was a similar violation of Nature's laws to the Asiatic despot, who felt justified in treating the traveler as a liar who told him of it. Had Dr. Carpenter been his prime-minister, the traveler might have fared worse.

There is no better evidence of philosophic imbecility than a sentiment of the all-sufficiency of our present meagre knowledge of Nature. The proposition of Dr. Carpenter that all new, marvelous facts shall be treated as impossibilities, and the witnesses who, without any other motive than the love of truth, attest them at the expense of their own popularity, shall be treated as impostors (which means, made personally

infamous and consigned to the mercies of antiquated laws), embodies all the impulses of stolid ignorance and malignity which have in past ages warred against science and innovation by prisons and by death-penalties.

Every great discoverer introduces something to human knowledge different from the usual understanding of Nature, and is, therefore, by the Carpenterian rule, a fit subject for persecution. The rigorous application of this principle would check progress by a war upon the greatest benefactors of mankind—those who lead them into essentially new ideas of Nature. The rule is therefore *thoroughly satanic* in its moral aspect, while in its intellectual character it is *thoroughly stolid*, being a declaration of war against the increase of knowledge in certain directions forbidden by the bull of the materialistic pope.

Considered as an appeal to that great tribunal, the public, this little volume is an extraordinary piece of insolence—what would be called at any judicial tribunal a flagrant contempt of court, entitling the applicant to summary dismissal and punishment. Dr. Carpenter not only pronounces the public, to whom his book is an appeal, incompetent to decide, virtually telling every reader that he has no right to an opinion on what he has seen until Dr. Carpenter (or some one whom he recognizes as a colleague) has told him what to think; but he assumes, like a "border-ruffian," to expel every witness from court who testifies differently from himself. No matter how pure the character, or how lofty the intelligence, if they disagree with him they are falsifiers; but, as to all who agree, their testimony is valuable, no matter how contemptible its source.

It is pitiable to see a gentleman of Dr. Carpenter's standing reproducing the obsolete trash which public intelligence had buried in oblivion. The toe-joint and knee-joint theory of rappings was speedily exploded in America, and has scarcely been heard of for twenty years. Rappings have occurred in thousands of families, in spite of their incredulity, and compelled them to recognize an invisible power which acts sometimes with force sufficient to break furniture, and to be heard at considerable distances. As Dr. Carpenter manifests a remarkable ignorance of the progress and present status of spiritualism, it is probable he does not know that the joint-rapping certificate to which Mrs. Culver's name was attached was refuted immediately after its publication. The *séances* she describes never occurred at all, Catharine Fox being at that time seventy miles distant at Auburn. How unmanly, how much like a malignant village gossip, in Dr. Carpenter to dig up decomposed slanders, when the lady concerned, now Mrs. Jencken, was in London, and he might at any time have satisfied himself in an hour of the reality of true spirit-sounds and other phenomena!

Throughout his long career, Dr. Carpenter has kept himself willfully ignorant of mesmeric and spiritual facts, which are easier of access

than almost any other scientific phenomena. He has reproduced the career of Horkey with remarkable fidelity. No sincere inquirer has ever failed, if he made proper efforts, to obtain evidence of an active intelligence which is not material. In my first interview with a medium, over twenty-five years ago, loud sounds—not raps, but sounds like the creaking of a wooden mill—were freely produced at request in a small uncovered table in our parlor, when no person was in contact with it or within three feet of it. On making careful examinations, the sounds appeared to be developed in the loose marble slab which constituted its top, and, by feeling the slab on both sides, I could locate the sound and vibration with great accuracy in its centre. When no one was touching the table, it was held down by the spirit-power, when requested, with a force which I estimated at twenty pounds in lifting it.

But it is entirely useless to mention any such facts to bigots of the Carpenter class, or to sustain them by any amount of testimony; for to them all testimony is worthless concerning anything outside of the limit which Dr. Carpenter has marked off with a grand Cardinal Richelieu flourish, as the impassable limit where inquiry must halt and vituperation begin.

Great is the power of the speculative scientific dogmatism which enabled Dr. Carpenter to show in his "Physiology" that one hundred pounds of starch would support the life of a savage as long as four hundred pounds of venison or other game (Chapter VII. Of Food and the Digestive Process), although it would be as difficult to convince the unscientific savage that such an opinion is preferable to experience as to convince Crookes, Wallace, Flammarion, Hare, or even Victor Hugo, that Dr. Carpenter's *opinions* are preferable to their own careful observations.

Worthless as this book seems as an argument, and amusing as it is to those at whom it is aimed, it has some power for mischief—the power of a demoralizing *example*—the power of position and reputation in giving a quasi-respectability to that which is philosophically silly and ethically corrupt. The most demoralizing influence which proceeds from a thoroughly depraved society is the doctrine that all men are knaves or fools, to which Dr. Carpenter has given his active cooperation—saving only a few self-styled "experts" from this satanic maxim. His unfair example is corrupting to scientific literature. The vast amount of mesmeric facts, which could scarcely be summarized and classified in the limits of his book, has been carefully ignored, and his readers would not suspect their existence, if dependent on him for information. Yet, as he is such a stickler for the scientific qualifications of witnesses, why could he not even *allude* to the testimony of Prof. Agassiz, who ranks before the world *at least* as high as himself? Prof. Agassiz was thoroughly mesmerized by the Rev. C. H. Townshend, and his letter describing his sensations and condition during the

process (February 22, 1839) is published in Townshend's "Facts in Mesmerism."

As the limits assigned this essay do not admit a complete review of this little book, it may now be dismissed, but not to oblivion, for it is destined to survive all other writings of Dr. Carpenter, and to be remembered as long as Horkey's letter against Galileo. Posterity will be amused to think that Whately's "Historic Doubts" concerning the existence of Napoleon Bonaparte, written for amusement, were more than matched by Carpenter's doubts of the existence of any mesmeric or spiritual facts, written in all the earnestness of a dogmatic and infallible philosophizer. In the struggle between stubborn vituperative materialism and comprehensive science, the battle-ground is at the psycho-physiological junction of the two worlds. Man, belonging to both the spiritual and the material world, cannot be properly studied except as a psycho-physiological being, and those who refuse to do this simply ignore anthropology. The effort of ultra-bigoted materialists is to exclude all agencies not thoroughly material—all that is intermediate between the psychic and the physiological—to crush its students and teachers by personal or professional ostracism and accusations of lying knavery and hallucination. The *malignity* of the attacks is sufficient proof that they do not originate in the love of science or of truth, even if they were not often distinguished by mendacity, the mildest example of which is the late assertion of Dr. Forbes Winslow, of London, that "this form of delusion" (spiritualism) "is very prevalent in America, and the asylums contain many of its victims; nearly 10,000 persons having gone insane on the subject are confined in the public asylums of the United States." This is quite *a fair example of the truthfulness* of the majority of the statements on that side of the question. The fact is, however, that the published reports of our fifty-eight insane asylums show but 412 from religious excitement, which is less than two per cent. of the whole number, and but 59 from spiritualism, which is twenty-six hundredths of one per cent. of the whole number in these asylums (23,328).

Dr. Carpenter and the majority of physiologists prefer to cultivate physiology as a purely material science, and reduce man as nearly as possible to a chemical and dynamic apparatus. I have preferred to cultivate physiology in a more philosophic way, recognizing the eternal man who inhabits the body, as well as the transient physical form, and discovering a new class of facts which render our chemical and anatomical physiology far more philosophic and intelligible. What a blind groping in the dark rigidly materialistic physiology appears to one who has gained that full knowledge of our complex constitution which constitutes our *anthropology!* I do not mean by this that mesmerism and spiritualism combined with mechanical physiology constitute anthropology: far from it. Both mesmerism and spir-

itualism are rich but empirical collections of facts, in which there is a large amount of material, but very little that can be called philosophy or satisfactory science.

Anthropology is established by investigating the centre of man's existence—the seat of his conscious life—the brain, in which the spiritual comes into contact with the physical, and is subject to analogous laws. In this theatre of their joint action both may be studied, and we may find that philosophy for which the world has so long been looking in vain, which shall comprehend the entire scope of human existence.

As one of these numerous psycho-physiological discoveries which are receiving daily confirmation from pathology, from autopsies, and from Dr. Ferrier's interesting experiments, I would very briefly allude to *psychometry*, a few experiments in which, if rightly conducted, would dissipate the entire fabric of physiological materialism. The discovery of psychometry and the introduction of the word by myself, thirty-four years ago, have made it quite familiar to liberal minds throughout the United States, and to some extent abroad.

The initial facts which I discovered in 1841, that all who have a high development of sensibility are capable of feeling the influence of any substance held in the hands, even to the extent of perceiving its taste as well as its medicinal effects, led to far more marvelous developments. The supposition of materialism has always been, that when medicines affect the body from contact with the exterior, an appreciable quantity of the substance must have been absorbed into the circulation. Against this theory I guarded by placing the medicines in an envelope of paper, which prevented contact with the cuticle, and concealed the nature of the substance from the knowledge of the subject of the experiment. In making such experiments I found that from twenty-five to thirty per cent. of the persons tried could realize distinct medicinal effects, corresponding to the nature of the medicine. In one of my collegiate classes of medical students (in 1849, some of whom have since occupied honorable public positions), the effects were distinctly recognized by forty-three, whose statement was published at the time. These effects would begin in the hand, ascend the arm to the head, and rapidly diffuse over the whole body.

If the materialist supposes that the substance passed through the dry paper to the dry hand, through its unbroken cuticle and up the arm, I would ask, How long would it take for twenty grains of tartar-emetic or of quinine to be exhaled through the paper? I am not aware that such substances when dry are ever materially diminished in weight by being kept in dry paper.

Omitting other associated facts and philosophy for want of space, I pass on to the consummation, that persons who realize *with facility* these medical impressions can also realize *psychic* impressions of the most subtle character, in such a manner as to dissipate all doubt of the reality of this wonderful power. A manuscript from any source

retains in itself a subtle psycho-physiological emanation characteristic of its writer; and an impressible person with a fair endowment of the psychometric faculty, to such an extent as we would find in perhaps one person in twenty, or, in some southern communities, one person in five, is capable of feeling the entire mental and physical influence of that person as perfectly as if in contact with himself, and describing the individual as he was at the time of writing—his entire mental and physical condition. When there is a high endowment of the psychometric faculty, the descriptions of characters made in this way are more subtly accurate than those from any other source, and the sympathetic impression of the physical condition is so vivid as to develop in the psychometer the pains and morbid conditions of the writer.

In the proper performance of the experiment, the psychometer is not allowed even to see the manuscript, which is used by placing it on the centre of his forehead; nor is he assisted by leading questions. It sometimes happens that, if the character described be one with which the psychometer is familiar, he will finally be able to recognize it, and tell the name of the writer by the identity of the character. For example, while writing this article yesterday, a lady, of considerable intellectual reputation and elevation of character, came in, whom I knew to possess fine psychometric powers. Thinking that I might make a suitable experiment upon her for the illustration of my subject, I selected one of my autographs, and requested her to give me an example of her powers. She knew not what autographs were in my possession, and was not allowed a view of the manuscript, which was placed on her forehead without being seen, and without the slightest hint or suspicion of its nature. In a few moments (holding it to her forehead by her finger) she manifested great mental excitement, and described a character of unusual grandeur and moral elevation. She felt like a great leader to whom multitudes were looking up—a man of commanding stature, of immovable firmness and strength of character, and the loftiest philanthropy. She could hardly refrain from rising up and striding over the floor, from intense excitement. After giving a forcible description of the character, she said she was sure it must be General Washington, as it corresponded to her knowledge of his character, with which she was quite familiar. I then took the paper from her forehead, to let her see this autograph, on which she had been pronouncing:

"*To all to whom this writing shall come.*

"I certifye, that William Morgan Esquire, commands a company of voluntoors in the service of the United States of America.

"Givon at Head Qrs. at Morristown this 25th day of Febry 1777.

"G. WASHINGTON."

Ever since my announcement of this discovery, in 1843, I have found it the most perfect agency ever devised for the investigation

of character, and it has become well known throughout the United States. There are as many as a score of practitioners of psychometry who will send a written description of the character connected with any manuscripts sent them, and a number of physicians who, with great success, use their psychometric power for the diagnosis of the condition of patients at a distance.

But experiments and investigations would be entirely useless if Dr. Carpenter could succeed in his aim to build an impassable wall for the exclusion of all *essentially novel* truths, by denying the competency of scientific testimony to introduce new facts foreign to his own cramped conceptions of Nature.

To exclude the multitudinous facts of mesmerism, including the vast number of surgical operations and marvelous cures in which it has been employed by Dr. Esdaile, Dr. Elliotson, and hundreds of others of unquestionable character—to exclude the facts of spiritualism witnessed by millions, and to combine all the incompatible powers of medical and clerical bigotry now, as the Aristotelians and Romish priests combined against Galileo—is a task in which his success will hardly equal that of Lactantius in denouncing the wicked innovations which asserted the existence of the antipodes.

THE DECLINE OF PARTY GOVERNMENT.

By Professor GOLDWIN SMITH.

THE late presidential election appears likely, in its results, to mark an epoch not only in the political history of the United States, but in that of all constitutional countries. In the person of the new President the American Government has come out of party and is trying to be the government of the whole nation. Sir Robert Peel tried the same thing in England, though in his case the "splendid perfidy" to party was less marked than in the case of Governor Hayes, because the repeal of the corn laws was not more essential to the interest of the country, which it rescued from death, than it was to that of the Conservative party, which it rescued from hopeless opposition to the nation and from utter political ruin. Party found a dagger with which to stab Sir Robert Peel. President Hayes has shown himself a strong man, but the greatest trials of his strength are still to come. When Congress meets he will have to contend both with the resentment of the regular managers of his own party and with the hostility of the thorough-going Democrats, who will see their opportunity in the breach between the President and the party which raised him to power, as the Whigs in 1846 saw their opportunity in the breach between Sir Robert Peel and the Protectionist section of his followers. Supposing, however, that President Hayes, like

Peel, should fail, his attempt, like that of Peel, will have a significance which no momentary failure can annul. It announces the decline of the party system, and the advent, not immediate, perhaps, but still certain, of national government.

It is curious with what implicit faith we have all reposed upon party, as the normal, permanent, and only possible mode of carrying on a free constitution, disregarding not only the objections which reason obviously suggests to the system and the general evidences of its bad effects on politics and political character, but the facts which showed plainly enough that its foundations were giving way, and that, if this was the only basis of government, government was likely to be soon left without a basis.

Burke, in his "Thoughts on the Cause of the Present Discontent," has given at once his definition and his defense of party:

"Party is a body of men united for promoting by their joint endeavors the national interest upon some particular principle in which they are all agreed. For my part, I find it impossible to conceive that any one believes in his own politics or thinks them to be of any weight who refuses to adopt the means of having them reduced into practice. It is the business of the speculative philosopher to mark the proper ends of government. It is the business of the politician, who is the philosopher in action, to find out proper means toward those ends, and to employ these with effect. Therefore every honorable connection will avow it as their first purpose to pursue every just method to put the men who hold their opinions into such a condition as may enable them to carry their common plans into execution with all the power and authority of the state. As this power is attached to certain situations, it is their duty to contend for these situations. Without a proscription of others they are bound to give to their own party the preference in all things; and by no means, for private considerations, to accept any offer of power in which the whole body is not included; nor to suffer themselves to be led or to be controlled or to be overbalanced, in office or in council, by those who contradict the very fundamental principles on which their party is formed, and even those upon which every fair connection must stand. Such a generous contention for power, on such manly and honorable maxims, will easily be distinguished from the mean and interested struggle for place and emolument. The very style of such persons will serve to discriminate them from those numberless impostors who have deluded the ignorant with professions incompatible with human practice, and have afterward incensed them by practices below the level of vulgar rectitude."

To form a rational and moral basis for party, to prevent party from sinking into faction, the party leader from becoming an "impostor," and the "generous contention for power" from degenerating into a "mean and interested struggle for place and emolument," there must be, as Burke says, a particular principle on which the members of the connection are agreed in desiring that government should be carried on. Failing such a principle, party, and the golden haze with which Burke, according to his manner, has surrounded it, vanish, and leave a faction or a void.

The principle must not be a moral principle, because this would imply an organized opposition to morality on the other side, and the permanent existence of an immoral party; two parties always in active existence being plainly essential to the working of the system. You cannot, for example, have a party of purity, because this would imply, as its correlative and complement, a party of corruption, and it would be a grotesque arrangement to devote half your citizens permanently to the service and advocacy of corruption in order to maintain the machinery of your government.

The principle must be one of expediency. Parties, in other words, must be divided by some question of policy, about which honest men may differ. And it must be a question of sufficient magnitude to transcend in importance all other questions; of sufficient importance to warrant a man of sense and a good citizen in surrendering for its sake his private judgment on all other political subjects to the guidance of the party leader and the exigencies of the party struggle, and in doing his utmost to exclude from the legislature and the public service all men, however honest, however able, however useful in general respects to the country, who do not agree with him on the vital point. We need not use the invidious term *proscription;* the thing will be the same.

Now, it is manifest, in the first place, that the occurrence of such questions is exceptional, and not normal; they can seldom arise in fact except with reference to some organic change in the constitution, such as the transfer of supreme power from the crown to Parliament, or the change in the character of Parliament itself, embodied in the English Reform Bill of 1832. American slavery was an issue of a different kind and of still more transcendent importance; but it was one lying quite beyond the pale of ordinary politics. In normal times the occupations of legislatures and governments will be matters of current administration, not one of which is likely to form an issue of sufficient importance to swallow up all the rest and form a rational ground for the division of the nation into two organized parties struggling each to place its leaders in exclusive possession of the powers of the state.

In the second place, questions of expediency, however important, do not last forever; in one way or other they are settled and disappear from the political scene. Slavery dies and is buried. Parliamentary reform is carried out with all its corollaries, and becomes a thing of the past. What is to follow? Another question of sufficient importance to warrant a division of the nation into parties must be found. But suppose no such question exists, are we to manufacture one? That is the work to which the wire-pullers devote themselves in democracies governed by party, but the results seem hardly to correspond to our notion of the adamantine basis on which the political edifice is to rest forever.

Some astronomers say that the moon once had an atmosphere, but that she has exhausted it, and that she shows us what our planet will be when, in the course of ages, its atmosphere also shall have been exhausted. The colonies, in this matter of party government, may furnish an indication of the same kind to the mother-country. In Canada, for example, while New World society was struggling to repel the intrusive elements of the old *régime* forced upon it by the imperial country, and to extort self-government, the parties, though not altogether edifying in their behavior or salutary in their influence upon popular character, were at least formed upon real lines. But the struggle ended with the abolition of the state Church and the secularization of the clergy reserves. Since that time there has been no real dividing line between the parties; they have ceased to be truly directed to public objects of any kind; their very names have become unintelligible. Politics under such a party system must inevitably sink at last into an "interested contest for place and emolument" carried on by "impostors who delude the ignorant with professions incompatible with human practice, and afterward incense them by practices below the level of vulgar rectitude." It is needless to say what effects an incessant war of intrigue, calumny, and corruption, carried on by such party leaders, with the aid of the sort of journalists who are willing to take their pay, must produce on the political character of a community, however naturally good, and well adapted for self-government. Nobody is to blame. The blame rests entirely on the system. Lord Elgin found fault with Canadian parties for being formed with reference to petty objects, not to great questions. It is singular that so acute a man should not have asked himself where the great questions were to be found. Were they to be manufactured or imported?

Nothing is more curious than the ingenuity with which new reasons are invented for old institutions when the original reasons have ceased to exist. The advocates of the party system in countries destitute of party questions, at a loss for rational grounds of defense, take a desperate dive into psychology, and affirm that all men are by natural tendency either Conservatives or Liberals, so that the division of every community into two parties is not merely a practical exigency of politics but a general law of humanity. In that case Nature must have been peculiarly kind to certain politicians who are furnished with a double set of tendencies enabling them to appear in both the parties at different periods of their career. It is hardly necessary to prove that the varieties of natural temperament are numberless, and are still further diversified by the influences of position, age, and fortune; and that to divide any nation into two organized parties according to their temperaments would be an undertaking far transcending in absurdity all the fancies of Laputa. Yet such philosophy probably helps to cast a halo over a contest of "impostors,"

the character and objects of which could not otherwise escape the most "vulgar" eye.

We have an example of the tendencies of the system in the Australian colonies, if Australian journals may be believed. Whatever land-questions or other questions of an organic kind or of permanent importance there were, having been settled, and no basis for parties left, party government it seems in those countries is weltering in cabal, senseless faction-fighting, and all the concomitant evils. The worst arts and the worst men inevitably acquire an increasing ascendency in public life. Changes of ministry, brought about for the most part by mere personal intrigue, are of constant occurrence. Government is almost as unstable as in Mexico, and though the mode in which the revolutions are effected is less violent, they are perhaps not much less injurious to the political character of the people, or less likely to produce a complete disintegration of authority in the end.

Imitation of England has led the political world a strange dance. The Chinese shipwrights, when desired to build a vessel in place of one which had been disabled by dry-rot, produced an exact copy, dry-rot and all. Montesquieu fancied that the grand secret of English liberty lay in the separation of the executive and the judicial power from the legislative. With their union in the same hands liberty would end. This theory found general acceptance; yet at the very time when Montesquieu made this profound observation, the legislature had in fact got into its hands the executive, which it appointed by the vote of its majority, and the judiciary, which was appointed by the executive. But the effect of the notion is visible in the provisions of the American Constitution; and the consequence is an occasional dead-lock, arising from a conflict between the legislature and the executive, as in the case of President Johnson, who was impeached to force him into harmony with Congress. Again, the House of Lords has been taken for a Senate, and the check imposed by its mature and deliberate wisdom on the rashness of the more popular House has been supposed to be the grand safeguard of British legislation. The House of Lords is not a Senate, nor a second Chamber, in the sense in which the term is practically employed by the architects of new constitutions. It is an estate of the realm: it is a privileged order having an interest of its own separate from that of the nation at large, and defending its own interests, which are necessarily those of privilege, and therefore of reaction, by resisting every measure of political change as long as it is safe to do so. Of its revising precipitate legislation in an impartial sense no instance can be found. But other nations try to reproduce it in the form of a second Chamber, and they find, one after another, that, compose your second Chamber and appoint its members as you will, the result is either a nullity or a collision between the two Houses, in which the more popular House will probably prevail.

In the same way it has been assumed that the English system of party and of cabinets, which are committees of party, is the vital principle of constitutional government. But party in England has been the instrument, probably the indispensable instrument, of a chronic revolution. By the action of the party which in its successive phases has borne the names of Puritan, Whig, and Liberal, the Tudor autocracy has been reduced to a limited, or rather a faineant, monarchy, and the Tory oligarchy, once intrenched in the rotten boroughs, has been replaced by a House of Commons elected on a more popular basis; supreme power, in other words, has been gradually transferred from the crown and the aristocracy to the representatives of the people. All this time there has been a real ground of division and a question of importance supreme enough to warrant allegiance to a party. But the process is now nearly complete. Other questions, of which the name Radical is the symbol, will probably emerge, and may again furnish grounds for the action of party. As it is, the lines between the aristocratic and democratic parties remain, though their outline is confused, and the democratic party is paralyzed for the time by the Conservative reaction, caused mainly by a vast influx of wealth. But we have an inkling at all events in the present state of things, even in England, of the time when the materials for party will be finally exhausted, and when we shall be obliged perforce to look out for some other mode of working constitutional government. Bayonets have their uses, but you cannot sit on them. Party has its use as the organ of a pacific revolution; but it will not supply the permanent basis of a national government.

Even in the course of the revolution, effected by means of party in England, as often as the movement has been temporarily suspended by accident or lassitude, the weakness of the system has appeared. Between the fall of Jacobitism and the advent of the French Revolution, when there was no great party question on foot, but the offices of state were still put up as the prizes of success in the struggle of parliamentary factions, you had half a century of chaotic intrigue and corruption, broken only by the short dictatorship of Chatham, whose own conduct, in the cabals which drove Walpole into the war with Spain, was an example, if not of place-hunting, of place-storming, of the most flagrant kind. The boasted efficiency of party, as a detector and exposer of abuses, was then proved to be little sustained by facts; it was seen, neither for the first nor for the last time, that two factions, whatever their mutual hatred, may virtually combine to preserve a privilege of plundering the community, which each hopes to exercise in its turn.

Not only is the usefulness of party as a political instrument closely connected with the peculiar circumstances of English history; it is closely connected also with the peculiar circumstances of an age of unscientific politics, of combinations formed upon class interests, of

little independence of mind, feeble reasonings, and strong passions. With the advance of political knowledge, of independent thought, and it must be added of public morality, allegiance to party grows less possible, party discipline loses its hold, the cohesion of party is broken up and refuses to be restored. The better a party is in point of intelligence, individual sense of responsibility, individual regard for the public good, the less submissive to the whip, and therefore the weaker, it becomes; a singular result of the only perfect system. What do we see in England now? On one side is a party weak to the verge of impotence, unable to act together even for one evening, to all appearances hopelessly excluded from power; and this because it is a party of opinion, of individual intelligence, of individual conscience, of individual desire to improve the condition of the people. On the other side is a party overwhelmingly strong, acting under perfect discipline, and likely to be for an indefinite time master of the state; and this because it is a party of interest, which always unites, while opinion inevitably divides.

Efforts are made on the Liberal side tc compensate the weakness of mental independence as a basis of party union by increased stringency of organization. But these only bring more clearly to light the incompatibility of mental independence with the party system. In a recent number of this magazine we published a very graphic and interesting account of the political machinery used by the Liberal managers at Birmingham. We are not in a humor to quarrel with anything which in the present dearth of ability, especially of rising ability, in the House of Commons has helped to secure the election of Mr. Chamberlain. Nor do we overlook the fact that the spontaneous organization on the side of the Tories, in the shape of social connections and the tyrannical pressure they exert, is such that it can only be counterbalanced by artificial organization carried to a high pitch on the other side. But we must say that the use of such machinery does seem to involve a terrible sacrifice of those very habits of mental independence which it is the pride of Liberalism to promote. The absolute necessity of defending progress and the interests of the community at large against the despotism of a class alone reconciles us in any measure to the system. In the United States the masters of the party machines have everywhere taken the representation out of the hands of the people: you are practically not at liberty to vote for anybody but their nominees; and the Republican horse, to vanquish the Democratic stag, becomes absolutely the slave of its rider.

In the United States the opinion of the best judges, so far as we can gather it, is that the disorganization of the parties is increasing and is likely to increase. Nor is it possible to name any issues on which new parties can be formed. There is no question which, even supposing it to be of sufficient importance, would at all coincide with the existing lines; and a complete reconstruction of parties with a new

arrangement of the leaders and wire-pullers, irrespective of all personal connections, would be practically out of the question. Two alternatives will present themselves to the people: either a new mode of working constitutional government and maintaining the proper check on the executive must be found, or the President must be allowed to become something very like an elective dictator for a term of years.

The practice of setting up the offices of the executive as the prize of victory in a legislative contest carried on by the agency of party appears to be injurious alike to legislation and to executive government. It is injurious to legislation, because public men are constantly tempted to deal with legislative questions in the interest of their own ambition, for the purpose of paving their way to office, or strengthening their position there, not with a view to the proper objects of legislation; whence a number of unnecessary, premature, and dishonest measures. All the members of the Conservative party, before 1867, had recorded their opinions against a large extension of the franchise as tending to place political power in ignorant and irresponsible hands. They, then, to keep their party in office, and at the bidding of leaders who they knew had no other motive, themselves extended the franchise to the most ignorant and irresponsible part of the population, the populace of the towns. The practice is injurious to executive government, because it excludes or ejects from office the ablest and most trusted administrators on account of opinions respecting legislative questions which in no way affect administration. It wrongly unites, in short, two political functions which are perfectly distinct and which mutually suffer by being bound up with each other.

It is needless to dilate upon the relations of party, its machinery, its strategy, the press which serves it and expresses its passions, to public morality and the general interests of the state; the facts are always before our eyes. But experience of a colony or of some new country is needed to make one thoroughly sensible of the effects of this warfare upon the political character of the people, and of the extent to which it threatens to sap the very foundations of patriotism and of respect for lawful authority in their minds.

It is supposed that the hostile vigilance of party is the great safeguard against political corruption, and one which, if removed, it would be impossible to replace. But there are some countries at least in which the indiscriminate slander in which party constantly deals forms really a cloak of darkness for all corruption rather than a lantern for the detection of any; while its effect on the character of public men is to produce general lowness of tone and brazen indifference to accusations of every kind. The experiment has not yet been tried of legislating definitely against the corrupt use of legislative or executive power, which is a perfectly tangible crime (at least it is difficult to see why the sale of a vote in a legislative assembly, or of a government contract, is not as tangible a crime as the fraudulent breach of an or-

dinary trust), and of instituting a tribunal for the trial of offenders. And therefore we are still at liberty, at all events, to entertain the belief that the sight of a single politician suffering a felon's doom by the impartial and righteous judgment of a court of law, for the corrupt betrayal of his public trust, would have a more salutary effect than the interested and reckless denunciations of all the party orators and journalists in the world.

It is easy to see why, up to this time, party has been the law of politics; but it is not easy to see why, for the future, and as reason extends its sway over the political sphere and limits the reign of passion, party should be the law of politics more than of any other subject. Party, we mean, organized and permanent; such as the parties of the Guelfs and Ghibellines, of the Blacks and Whites, of the Caravats and Shanavests. On social and philanthropic questions, on questions and in movements of all kinds, people combine for a particular object, and the object having been gained they fall back into their ordinary associations. Why should they not do the same in politics, supposing politics to be a matter not of passion and ambition, but of reason and of the public good? This is the answer to the argument on the side of party that nothing can be carried without combination. It can hardly be necessary to meet the argument that political truth can only be hammered out by the constant collision of parties. With regard to all other subjects it is supposed that while free discussion is conducive to the discovery of the truth, party feeling and subserviency to party are most adverse to it. But people tacitly assume that they can have party without party feeling and the evils to which every one, when the question is distinctly proposed to him, admits that party feeling must lead.

Nor, again, need we dwell long on the argument that party is necessary in order to keep up an interest in human affairs. Human affairs, according to all present appearances, are likely to be interesting enough to keep the mind of man alive and to give birth to abundance of controversy (if that is the thing desired) for generations to come, without our forming artificial parties for the purpose of enabling ambitious men to obtain exclusive possession of the power of the state.

Party is no doubt indispensable to selfish interests, which by taking advantage of the balance of factions are enabled, to an almost indefinite extent, to compass their special objects at the expense of the community. It is indispensable to political sharpers who, without legislative powers or any sort of ability or inclination to serve the public in any honorable way, find subsistence in an element of passion and intrigue. To whom or to what else it is indispensable, no one has yet been able definitely to say.

Burke himself, the great apologist of party, was the great apostate from it. He called his apostasy fidelity to the Old Whigs; but the Old Whigs were in their graves, and the rhetorical turn given by him

to his secession did not alter the fact. In the case of his defense of party, as in many other cases, his fervid and unbridled imagination has erected a particular expedient, the necessity of a special occasion, into a universal and everlasting law. Before him, another man had shaken off party trammels apparently from the conviction of their radical inconsistency with the public interest. The life of Lord Shelburne is in this special respect a most important, as well as in all respects a most interesting, addition to political biography, and we shall see as it proceeds whether Shelburne is entitled to the credit of having tried to be a national statesman.

Our proposition, however, is this: that, let party, as a system of government, be good or evil, the materials for parties are nearly exhausted in the British colonies, and probably in the United States; that they are temporarily exhausted, and may one day be entirely exhausted, in England; while in other countries (in France and Germany, for instance) the sections and subsections of opinion are too numerous and the lines between them are too wavering to admit of the clear division into two parties absolutely essential to the working of the system, which, when there are three or four parties instead of two, becomes a quicksand of intrigue on which no government can be founded. Under these circumstances it is necessary, whether we will or not, to look out for some other foundation for constitutional government. The penalty of not doing so will be either confusion or the domination of some selfish and, because it is selfish, compact and all-powerful interest.

To determine what that foundation is to be, is probably a task reserved for better heads than ours. But perhaps the Swiss Constitution, in its general principles, may point the way. It suggests the regular election of the executive council by the legislature in place of a struggle of parties to determine which side of the House shall have the privilege of distributing the prizes among its leaders. The proper relations between the legislature and the executive might be preserved by a proper rotation of elections, with any such provisions as seemed expedient in the way of cumulative voting. The tenure of office would of course be limited; whether to the duration of the Parliament (which is the Swiss system) or to a term of years would be a question of detail, but the advantage of a continuous executive would be in favor of the latter plan. It does not seem that with this limitation the power of the members of the executive council would be too great, or that their responsibility would be unduly diminished; excess of authority, provided it be constituted in the interest of the whole nation and accountable to the nation in case of an abuse of power, is not the political danger which at present we have most reason to dread. Nor does it seem that, with, say, three elections occurring each year, the executive council could get much out of harmony with the legislature, or fail pretty adequately to represent the prevailing

sentiment of the legislature for the time being. But the executive under such a system would do its own work, and leave the legislature free to do the work of legislation. The special initiation of the Minister of Finance in financial matters would be preserved by the same sense of an obvious necessity which has established it. In the performance of purely administrative duties, all the members of the council might without difficulty agree, and their coöperation in their proper work might be perfect, notwithstanding possible differences of opinion about matters of legislation. Why should not a good Chancellor of the Exchequer act in harmony with a good Home Secretary notwithstanding a difference of opinion about the church establishment or the extension of the franchise? Why should the country be prevented by that difference from availing itself of the administrative capacity of both? And why should not each be free to vote as a member of the legislature, in accordance with his personal opinion? At present a cabinet has something of the character of a conspiracy, members often suppressing or even acting against their own opinions in order to present a united front to the enemy and to maintain their hold of power, from which no small calamities have flowed. It would not be difficult to point to instances of measures forced on a cabinet by some leading member, his colleagues acquiescing merely from fear of a break-up, and then carried through Parliament by the influence of government, though the sense both of the legislature and the cabinet was really the other way.

The tendency inherent in party government to supersede the national legislature by the party caucus has long been completely developed in the United States, where it may be said that in ordinary times the only real debates are those held in caucus, congressional legislation being simply a registration of the caucus decision, for which all members of the party, whether they agreed or dissented in the caucus, feel bound by party allegiance to record their votes in the House; just as the only real election is the nomination by the caucus of the party which has the majority, and which then collectively imposes its will on the constituency; so that measures and elections may be and often are carried by a minority but little exceeding one-fourth of the House or the constituency, as the case may be. The same tendency is rapidly developing itself in England; and it is evidently fatal to the genuine existence of parliamentary institutions.

So far as England is concerned, the institution of an executive regularly elected by the legislature at large in place of a cabinet formed of the leaders of a party majority would be substantially a return to the old form of government—the Privy Council. Parliament is now the sovereign power, and election by it would be equivalent to the ancient nomination by the crown. The mode of electing and confirming a Speaker shows how the forms of monarchy may be reconciled with the action of an elective institution.

However, be the proper substitute for party what it may, the thing here insisted on is that party is evidently in a state of decadence; that the causes of its decadence are not accidental or temporary, but inherent in its nature, which is that of an instrument of change, not that of a permanent principle of government; and that, consequently, sooner or later some other basis for government must be found. "You are sanguine," say objectors, "if you think you can carry on constitutional government without party." We trust not; for, if it is so, the end of constitutional government is at hand. The decline of party may fairly be said to present an urgent question: for the political observer to-day—to-morrow for the statesman.—*Macmillan's Magazine.*

SKETCH OF PROFESSOR JEVONS.

WILLIAM STANLEY JEVONS was born at Liverpool, in the year 1835. His father, Thomas Jevons, was an iron-merchant in that city; his mother was a daughter of William Roscoe, the well-known historian. She was a woman of great cultivation, the writer of hymns and poems which are to be found in general collections, and the editor of the "Sacred Offering." Young Jevons received his early education along with his cousin, Prof. Roscoe, at the High-School of the Mechanics' Institution, Liverpool, the head-master of which was, at that time, Dr. W. B. Hodgson, now Professor of Political Economy in the University of Edinburgh. At the age of sixteen he went to University College, London, and, during the two years he remained there, distinguished himself highly in the classes of mathematics and natural science. In 1853 he received, on the recommendation of Prof. Graham, the offer of an appointment as an assayer to the Australian Royal Mint at Sydney. He accepted this appointment, and, after having qualified himself by a course of assaying under Profs. Graham and Miller, he proceeded to Sydney, where he discharged the duties of the office for five years, devoting his leisure time to scientific investigations, particularly meteorology. He, however, resolved to leave this field of work and devote himself to the study of the higher sciences. Returning from Australia, he visited the United States in 1859, and, arriving at London, he at once resumed his studies in the University College, and won distinction in his various classes. In 1862 he graduated as M. A. with first-class honors, and the gold medal in the department of Logic, Philosophy, and Political Economy. Two years later he was elected Fellow of University College.

In 1863 he published his first important work on economical science, entitled "A Serious Fall in the Value of Gold ascertained, and its Social Effects set forth." He consented to take the position of tutor in Owens College in 1863, and in 1866 was elected to the chair of Logic and Political Economy in that institution. The year pre-

vious he had read to the British Association a paper containing the fundamental positions of his later work, "Theory of Political Economy." In 1865 appeared the treatise "On the Coal Question," dealing with the problem of the exhaustion of the English coal-mines, the calculations of which were adopted by Mr. Gladstone and Mr. Mill in their treatment of the subject. In 1869 appeared the small work, "Substitution of Similars the True Principle of Reasoning;" in 1870 he read a paper before the Royal Society "On the Mechanical Performance of Logical Inference;" and about this time he completed his well-known Logical Machine. In 1870 appeared the first edition of the "Elementary Lessons in Logic." The "Theory of Political Economy" was published in 1871; and the author's great work, "The Principles of Science," was issued in two volumes in 1874.

"The Principles of Science" is a comprehensive treatise on pure and applied logic, or on the formal theory of inference and the methods of scientific investigation. The first book resumes the author's previous researches in pure logic, and carries them a step further. All inference is regarded as essentially reasoning from similars to similars, affirming that what is true of one thing is true of its like. The rules of inference flowing from this general principle, and the symbolical notation employed to express all the forms of thought, are stated and exemplified with great fullness. The particular novelty introduced is the view of induction, which Prof. Jevons regards as merely the inverse process of deduction. Thus, in deduction, we have given to us certain relations among terms or notions, and by the application of the formal laws of thought we develop all the possible combinations which are consistent with given relations. In induction, on the other hand, the combinations of terms are given, and we require to reason backward to the possible relations from which they may result. Insisting strongly upon his view of inductive inference, Prof. Jevons is led to criticise and reject the ordinary accounts of the process. He declines to admit that inductive research necessarily involves the idea of causation, and assimilates it more nearly to the mathematical doctrine of probability. The chapter in which he expounds the philosophy of inductive inference is peculiarly valuable, and deserves more careful criticism than it has yet received. As final result we have the complete subordination of induction to deduction; all inductive research, according to Prof. Jevons, consisting of three steps—framing an hypothesis as to the general law, deductively inferring results from it, and comparing the inferred conclusions with real fact.

The subordinate points involved in this theory of induction, such as the principles of combination and the general method of calculating probabilities, are treated very elaborately. The problem of inverse probability, which is, in Prof. Jevons's view, identical with the problem of induction, receives most careful attention. Some attempts have recently been made to carry out one or two of the elaborate

logical computations shown to be necessary for the complete solution of the problem.

The remainder of the treatise is an exhaustive account of the methods of scientific investigation. What is most remarkable in this portion of the work is the combination of extensive and accurate knowledge of facts with perfect command of the most general principles. As a writer on scientific method, Prof. Jevons is fairly entitled to the credit of being a peer of predecessors so eminent as Herschel, Whewell, and Mill. He has given the fullest and best exposition of the methods actually employed by the greatest scientific workers, and has collected from all quarters a mass of most richly-varied illustration.

The concluding book of the treatise is a brief but pregnant essay on the results and limits of scientific method. The outcome of the author's careful analysis of induction, the essentially *probable* character of what are called natural laws, is applied as a corrective to the rash scientific generalizations indulged in by many writers, and to the equally rash deductions from them. At the present time his weighty remarks on the supposed contradiction between natural law and divine providence in any form are peculiarly deserving of attention.

Prof. Jevons published a volume, in 1875, entitled "Money, and the Mechanism of Exchange," forming part of "The International Scientific Series." It contains a lucid and admirably-written exposition of the nature and functions of money, the principles of circulation, the various forms of credit documents, and the elaborate mechanism (banks, check, and clearing systems) by which money exchanges are facilitated. Careful and complete historical notices are also given with regard to the various metallic currencies, modes of coinage, and regulations of issue, while technical matters, such as the qualities requisite for good metallic currency, the loss of weight in coins by usage, and the cost of keeping up the currency, receive due attention. His last publication was the little compendium of logic called "The Logic Primer," intended to give general readers some idea of this science.

In 1868 Prof. Jevons was appointed an Examiner in Political Economy in London University. In 1870 he was President of the Economic Section (Section E) of the British Association at its Liverpool meeting. In 1872 he was elected a Fellow of the Royal Society. In 1874 and 1875 he was an Examiner for the Moral Sciences Tripos at Cambridge. In the year 1876 the Senatus Academicus of Edinburgh University conferred upon him the honorary degree of LL. D.; and in the same year he was appointed Examiner in Logic and Moral Philosophy in London University. In March, 1876, Prof. Jevons announced his resignation of his professorship at Owens College; and in October, 1876, he entered upon the duties of the distinguished position to which he had been chosen, and which he now occupies, as Professor of Political Economy in University College, London.

CORRESPONDENCE.

"THE TIDES."

To the Editor of the Popular Science Monthly.

I HAVE read with a good deal of interest Prof. Schneider's article on "The Tides," in the July number of the MONTHLY. I was pleased with his method of approaching the problem, because it deals with the planetary bodies as we actually see them in motion, not demanding that effort of the imagination required in studying the problem simply as one of static equilibrium. He has succeeded in rendering tolerably intelligible from a new standpoint a subject which is perhaps left for the average reader in a somewhat unsatisfactory state in our popular works on astronomy and physical geography.

In proportion as he has done this portion of his work well, is any error of statement into which he may have been led liable to prove mischievous. This is my only excuse for venturing to offer any criticism on the work of one who has really done valuable service in presenting familiar truths in new aspects.

Nowhere is our author more clearly wrong than in his own criticism of the commonly-accepted theory of the causation of the tides. He admits, apparently, that the attraction of the moon, or of the sun, is capable of lifting into a tidal protuberance the waters that lie, in popular parlance, directly beneath them; but that the earth itself should be drawn away from the waters upon its opposite surface, he pronounces preposterously absurd. "It has been proved experimentally," he says, "that all bodies on the surface of the earth are heavier at midnight than at any other hour of the twenty-four." He cites no authority for this statement, which is simply inconsistent with the observed fact that at midnight, leaving out of account the influence of the moon, the tide is rising instead of falling. The state of the tide, however, as we shall perhaps have occasion to indicate hereafter, is not a trustworthy measure of the local variations in that gravitative force which manifests itself as weight. Unless, therefore, delicate experiments with the pendulum have actually demonstrated the existence and amount of such diurnal variations, we can only infer them from our knowledge of the forces which may produce them.

It is in his attempt to do this that our author falls into the fatal confusion of thought which leads him to pronounce absurd a theory which to the clear-sighted Newton was simply the truth. This confusion seems to arise wholly from a careless use of the term *weight* or gravity. On the side of the earth facing the sun, all particles of matter feel the attraction of the earth and that of the sun as forces acting in opposite directions. "The weight of a body situated at this point then will be diminished by precisely the amount of the sun's attractive force." Yes, if meanwhile the earth's centre remain stationary. But this is not the fact; the whole mass of the earth has simultaneously yielded to the solicitation of the same attraction. If these motions are equal, they can produce no change in weight, for weight is simply the force with which a body tends to approach the earth's centre, not simply the force with which it advances through space in the direction of that centre. Prof. Schneider himself points out the distinction, but proceeds immediately to ignore it in his reasoning. He says: "As the particles of the earth most remote from the sun feel its attraction *plus* that of the earth herself, they are drawn with greater force *toward the centre of the earth* than any other particles. Hence," he triumphantly asserts, "it cannot be true that the whole earth is drawn away from the waters, and that any tide is produced by the waters being left behind."

Having thus convincingly (?) shown the necessity for a more satisfactory hypothesis regarding the causation of the tides, he proceeds to offer one of his own. The first thing we remark, however, in examining this is that it embodies all that was contained in the old "absurd" hypothesis, while it complicates the problem by compelling us to consider not only the attraction of the sun or moon, but also the antagonizing force which prevents the earth from moving in the direction of the attracting body. It is true that by an ingenious misstatement of his own theory the writer avoids what to him seems paradoxical in that which he rejects. One of the tides—that on the side of the earth facing the disturbing body—he tells us, is produced by centripetal, the other by centrifugal force. In an explanatory paragraph he admits, although he does not distinctly state, what is the fact, viz., that in each case coinciding effects are produced by simultaneous variations in opposite directions of *both* these forces. Recognizing, however, the supreme value of directness and simplicity of statement in all popular expositions of scientific truth,

we are disposed to overlook inaccuracies such as these, lying merely on the surface. It is otherwise with anything that betrays confusion of thought in regard to the fundamental elements of the problem. This, it seems to me, the writer has done in ascribing to centrifugal force a primary place in the causation of tides. It is only as the waters upon the earth's surface have freedom of motion—are acted upon, therefore, as independent of the earth's mass—that tides are possible. On the other hand, only in so far as the waters take up by friction and cohesion of their particles the motion proper to the portion of the solid earth underlying them, will they acquire the increased tangential momentum which constitutes the so-called centrifugal force. When it is understood that the force in question operates only in this indirect manner, it becomes plain that it ought not to be classed with gravitation as a primary cause of the tides, but rather with the rotation of the earth as an important secondary factor, necessary to be studied in tracing out the actual operation of their real cause.

The new mode of explaining the observed phenomena is, however, on the whole, quite intelligible and satisfactory in its application to the solar tides. It requires a greater effort of the imagination to see exactly how the same principles operate in the causation of the lunar tides. It is easy to understand how centrifugal force will predominate on the side of the earth opposite the moon, and how the waters on the nearer side will tend to insphere themselves about the centre of gravity of the rotating system, a point only 2,687 miles from the earth's centre. There is some difficulty in taking on trust the statement that the earth will feel on the side facing the moon a centripetal force equal to the centrifugal force which is said to cause the tide on the opposite side, when we remember that the moon itself is a part of the rotating system, and must itself claim a share, however small, of the forces, centrifugal and centripetal, whose balancing equivalents are to be sought on the remote side of the earth. And it is far from clear to the tyro in mathematics why high tide should occur directly under the moon, where centrifugal force, acting in a direction away from the earth's centre, is but slight, while centripetal force, *acting in the opposite direction*, is at its maximum so far as it is dependent on proximity to the centre of rotation. Although the explanation of this latter apparent paradox is by no means difficult, it will certainly prove to many a fertile source of perplexity.

The interest I have myself taken in applying Prof. Schneider's hypothesis to the numerous practical problems which arise the moment we pass in our study from hypothetical tidal waves to the actual movement of the waters of existing oceans, has led me to jot down the above points in the way of friendly criticism. For the rest, I would rather listen to some abler critic.

A. B. Lyons, M. D.

Detroit, *June* 27, 1877.

THE NEW IDEAS ABOUT SPACE.

To the Editor of the Popular Science Monthly.

Dear Sir: The letter of Prof. G. B. Halsted, of Johns Hopkins University, in your number for July, 1877, in regard to the imaginary geometry of Gauss, Lobatchewsky, and Beltrami, brings to my mind the fact that there is no necessary truth in many things that we have regarded (at least we mathematicians) as necessary truths.

Sir George Airy investigated the conditions under which perpetual motion might exist (Cambridge "Philosophical Transactions," 1830, vol. iii., pp. 369–372).

Newton's notion of negative density ("Principia," book ii., sec. ii., prop. x.) is another case.

Laplace, in the "Mécanique Céleste," has indulged in a remarkable speculation as to what the laws of motion would have been if momentum, instead of varying simply as the velocity, had been a more complicated function of it.

These things seem to overturn current metaphysics, and that is about all the good in them. Yet Reid, in what he calls the Geometry of Visibles, chapter xli. of his "Inquiry," raised a question of like nature. Hamilton, as noticed by George Lewes ("Problems of Life and Mind," vol. ii., Appendix), has avoided any comment.

By reason of the superb contempt which this extraordinary man affected for mathematics, I presume he thought it beneath his notice. Your obedient servant,

Lewis Kennon, M. D.

Fort Bayard, New Mexico, *July* 29, 1877.

THE WOODRUFF SCIENTIFIC EXPEDITION.

We give below an important letter from Prof. Wilder, of Cornell University, on the Woodruff Scientific Expedition, and would call the attention of those interested to the assurances it contains concerning the opportunities for study and the facilities for original work which the expedition is expected to afford. Prof. Wilder is a member of the faculty of scientific instructors, and also one of the trustees of the expedition. The letter, as will be seen, is in response to our inquiries:

To the Editor of the Popular Science Monthly.

Sir: In answering your inquiry as to the nature and extent of scientific work to

be attempted on the Woodruff Expedition, and the facilities therefor, I must premise: first, that the published list of professors does not include several who are expected to conduct special departments of botany and zoölogy; second, that the faculty have had no official conference, so that I can speak only for myself.

My own duties will include—1. *General* lectures on the habits and structure of vertebrates. These will be nearly free from technicalities, so as to be intelligible to all. 2. *Special* instruction of those who may wish to go more deeply in certain directions; this by superintendence of dissections, and occasional lectures. 3. Instruction in methods of collecting, preparing, and preserving specimens. 4. Preparation of, and research upon, embryos, brains, hearts, and other soft parts, which are usually neglected by foreign collectors.

The students will provide their own dissecting instruments, cans, and preservatives; but, as stated on page 21 of the announcement, the management engages to furnish a library and apparatus for instruction.

I understand such requisite apparatus to include nets, dredges, and sounding arrangements, chemical and physical instruments, microscopes, diagrams, blackboards, stereopticon, and the means of preserving certain typical forms for illustration of lectures.

To insure the fulfillment of the promises made in the announcement, the trustees are to control the transfer of the fees to the director. The trustees are also members of the faculty, and their interests are therefore identified with those of the students.

From what I know or have heard of those concerned in the management of the expedition and the instruction, I feel confident that all possible facilities will be afforded for the acquisition of general information, and for the pursuit of special lines of investigation.

Respectfully yours,

BURT G. WILDER.

ITHACA, NEW YORK, *September* 1, 1877.

EDITOR'S TABLE.

CARPENTER ON SPIRITUALISM.

THE recent publication of Dr. Carpenter's little volume entitled "Mesmerism, Spiritualism, etc., Historically and Scientifically Considered," has given a renewed impulse to the discussion of this subject, and called out the strongest champions of the doctrines assailed. We have been accused of unfairness in not opening the columns of the MONTHLY for the spiritualists to present their side of the question; and so we print two replies to Dr. Carpenter, one English and the other American, by distinguished representatives of the spiritualist party. In THE POPULAR SCIENCE SUPPLEMENT, No. V., appears the answer to him made by Mr. A. R. Wallace, in the *Quarterly Journal of Science;* and in our present number the reader will find an original contribution, to the same purpose, by Dr. J. R. Buchanan, well known for the last thirty years as an eminent investigator and expositor of the so-called spiritualist phenomena. Dr. Buchanan is one of those who objected to our editorial course on this question as one-sided and unjust. Not liking this imputation, we offered him space in our pages to answer Dr. Carpenter. He accepted the offer, and we fulfill our promise. How far his article is to be regarded as a reply to the reasoning of Dr. Carpenter, or as convicting him of error, will probably be a contested question with different classes of readers; but he has, at all events, given us his very decided opinion of that gentleman, his book, and his backers. We fear, however, that the critic has forgotten, for once, that denunciatory epithets, however profuse and peppery, are not arguments. Dr. Buchanan seems to have vividly remembered all the hard hits that he and his coadjutors have received from scientific writers, and is bent upon using the opportunity to get even with them. This is laudable enough, within judicious limits; yet incontinence of vituperation is a symptom of weakness. Besides, something is due to self-respect; and if we thought Dr. Carpenter was the silly,

narrow-minded, muddle-headed, pretentious, and insolent imbecile that Dr. Buchanan intimates, we would try and find better occupation than troubling ourselves about his obsolete trash.

Dr. Buchanan opens his batteries against the materialists, but might he not as well have left this to some irate theologian? This polemical dash cannot be effective against Dr. Carpenter, who is certainly no materialist, either by his own avowal, by the tenor of his writings, or their common interpretation. On the contrary, he is a religious man, who has written copiously and cogently against materialism. The term materialism, skillfully used, is no doubt a good controversial weapon for popular effect, but in the hands of Dr. Buchanan it loses its edge, as he seems to regard all science which limits itself to the investigation of Nature in its ordinary aspects as materialistic.

We cannot here go into this controversy, but may briefly refer to what we regard as one of its primary issues. At the threshold of the subject we encounter the questions, What is Nature? What are the limits of its laws? and, What weight, or logical force, is to be allowed to the conception of the laws of Nature? When observation, experiment, and reason, have concurred in establishing a principle which may be always verified and found to be constant, what is the degree of firmness with which it is to be held? Science recognizes the laws of Nature as so fixed and fundamental that the well-trained mind must be under an overwhelming predisposition in regard to them. Hence, when marvelous stories are told of the violations of these laws, the tendency of such minds must be to put them aside as unworthy of attention. They cannot be entertained as against the demonstrated uniformities of the natural world. Much in regard to Nature is, of course, unknown; what we understand may be as but a few drops to the ocean in relation to what we do not understand; yet some things *are* known, and with so high a degree of certainty that we can rest in them with profound assurance that no future extension of knowledge can falsify them.

Dr. Carpenter maintains, and we think rightly, that there is a strong bias in scientific minds in favor of the inflexibleness of natural laws which the spiritualists do not share. His language is, that "it is quite legitimate for the inquirer to enter upon this study with that 'prepossession' in favor of the ascertained and universally admitted laws of Nature, which believers in spiritualism make it a reproach against men of science that they entertain." Both our critics resent this imputation upon "believers in spiritualism." Mr. Wallace declares it to be "unfounded and totally false;" and Dr. Buchanan affirms spiritualists to be "the foremost of all men in insisting on the universal inviolability of all the laws of Nature, extending their infrangible power not only over all physical phenomena, but throughout the equally extensive psychic realm."

It is obvious that Dr. Buchanan here uses terms to suit himself, as he gives to the phrase "laws of Nature" a meaning very different from its established scientific significance. In its scientific sense, the term "Nature" designates that sphere of phenomena, material and mental, of which we have constant experience, which is accessible to the human faculties, and which by its order becomes a subject of methodical knowledge; while the laws of Nature are the uniformities of action that are coextensive with this sphere. To this tract Dr. Buchanan annexes a "psychic realm," meaning thereby, not the common sphere of mind which is already embraced by the term "Nature," but a super-mundane, extra-material, preternatural, or spiritual world, above and beyond the sensuous order. This supernal region he claims to bring under the operation of the laws of Nature,

and therefore to make it a part of Nature, which we hold is simply to confuse all distinctions and confound the natural with the supernatural. Dr. Buchanan cannot do this in the name of science, for science itself has only come into existence by marking off the natural from the supernatural, and it belongs by its very essence and origin to one term of this contrasted relation. We cannot undo the great work of science, and cancel all that has been gained in the intellectual progress of mankind, by going back to primitive times when the natural and the supernatural were all mixed up, and nothing was known or suspected of such things as the laws of Nature. It was then believed that there exists an upper sphere inhabited by gods who interfered as they chose with earthly matters; the spiritualists now believe in a corresponding ghost-realm, inhabited by disembodied spirits, who have still the power of meddling with the course of terrestrial affairs.

This ultra-material realm, it is claimed, is manifested by material effects. But it is not by those effects which occur regularly and uniformly, and to which we give the name of laws, that it is the office of science to trace out. These are not attributed to spiritual agencies. The spirits are never alleged to be the causes of cohesion, refraction, digestion, gravity, or any of the matter-of-course operations that go on around us. They are only disclosed to us by striking, wonderful, exceptional, or miraculous manifestations; that is, the common order of Nature gets along without them, and they are only known by breaking through it. In Nature we see with our eyes; in the "psychic realm" men are said to see with the backs of their heads. In Nature tables remain at rest upon the floor forever unless some definite terrestrial force is applied to move them; in the "psychic realm" they travel about or rise to the ceiling without the intervention of any earthly cause. In Nature a bouquet will not pass through the woody barrier of a door, or the resisting masonry of a wall; in the "psychic realm" "a large bunch of hollyhocks, asters, laurels, and other shrubs and flowers," is mysteriously spirited into a house without coming through the usual openings in the usual way by which material bodies are transferred. In Nature, if a man unguardedly loses his balance in a window, he falls to the earth; but in the "psychic realm" Mr. Home "floats in the air by moonlight out of one window and in at another at a height of seventy feet from the ground." In Nature, if we wish to go to a house, we must walk there or get a conveyance to be carried, and then can only get inside by the opening of some passage of entrance; but in the "psychic realm" buxom Mrs. Guppy "sails through the air all the way from Highbury Park to Lamb's Conduit Street, and is brought by invisible agency into a room of which the doors and windows were closed and fastened, coming plump down in the midst of a circle of eleven persons who were sitting in the dark shoulder to shoulder."

Can those who believe these things be said to maintain the laws of Nature? Certainly not, in any such sense as that which science affirms. The spiritualists say that these apparently miraculous effects are not really miraculous, but are simply the consequences of higher laws of Nature by which the lower ordinances of the material sphere are overcome. But it is clear that before the man of science can accept such astounding propositions he must give to the winds all those laws of the natural world which he has been accustomed to regard as of demonstrated constancy. In life, by all his resources, the most gifted man cannot suspend the operation of gravity upon a single particle of matter by an infinitesimal fraction. But when he dies we are taught that his ghost can come back, and suspend

the action of gravity, in a way to excite the astonishment of whole circles. And this miraculous prerogative, we are told, is, itself, but an exemplification of natural law. But, assuming the truth of the spiritualist's view, we have simply come to an end of natural law. If the wonders alleged be true, where is the basis of trust in the regular course of Nature? If the uniformities of phenomena that science assumes to have discovered can, as a matter of fact, be disturbed by the capricious incursions of unseen beings, then there are no such uniformities; and the conception of law, instead of being the most fundamental conviction of the scientific mind, is an illusion to be abandoned. Anxiety about the constancy of these laws is, however, the last thing that troubles scientific men, and their repose of mind upon this subject sufficiently accounts for their general indifference to the claims of spiritualism.

INDICATIONS OF PROGRESS.

Our readers will well remember the row occasioned last year when Prof. Huxley said that the evidence of the truth of evolution must be accepted as demonstrative. We mark with interest the decisive indications that are accumulating in confirmation of Prof. Huxley's position. Another President of the British Association for the Advancement of Science has spoken upon the subject, under the responsibilities of his distinguished position, and in entire corroboration of the avowals of former presidents of that body for the last dozen years in relation to this question. His indorsement of evolutionary doctrine is emphatic and unqualified. Prof. Allen Thomson has been well known as an eminent cultivator of biology; but he comes forward now as a new authority, and will be listened to without the prejudice which attaches to the names of those men who have been in the thick of the fight for the last twenty years. The topic of the presidential address is the "Development of the Forms of Animal Life," and we here quote the opening passages, describing the remarkable change in the manner of viewing biological questions which has taken place during the last half-century. President Thomson says:

"In the three earlier decades of this century it was the common belief, in this country at least, shared by men of science as well as by the larger body of persons who had given no special attention to the subject, that the various forms of plants and animals recognized by naturalists in their systematic arrangements of genera and species were permanently fixed and unalterable; that they were not subject to greater changes than might occur as occasional variations, and that such was the tendency to the maintenance of uniformity in their specific characters that, when varieties did arise, there was a natural disposition to the return, in the course of succeeding generations, to the fixed form and nature supposed to belong to the parental stock; and it was also a necessary part of this view of the permanency of species that each was considered to have been originally produced from an individual having the exact form which its descendants ever afterward retained. To this scientific dogma was further added the quasi-religious view that, in the exercise of infinite wisdom and goodness, the Creator, when he called the successive species of plants and animals into existence, conferred upon each precisely the organization and the properties adapting it best for the kind of life for which it was designed in the general scheme of creation. This was the older doctrine of 'Direct Creation,' of 'Teleological Relation,' and of 'Final Causes;' and those only who have known the firm hold which such views had over the public mind in past times can understand the almost unqualified approbation with which the reasoning on these questions in writings like the 'Bridgewater Treatises' (not to mention older books on natural theology) was received in their time, as well as the very opposite feelings excited by every work which presented a different view of the plan of creation.

"On the Continent of Europe, it is true, some bold speculators, such as Goethe, Oken, Lamarck, and Geoffroy St.-Hilaire, had in the end of the last and commence-

ment of this century broached the doctrine that there is in living beings a continuous series of gradations as well as a consistent and general plan of organization; and that the creation, therefore, or origin of the different forms of plants and animals must have been the result of a gradual process of development or of derivation one from another, the whole standing connected together in certain causal relations. But in Britain such views, though known and not altogether repulsive to a few, obtained little favor, and, by some strange process of reasoning, were looked upon by the great majority as little short of impious questionings of the supreme power of the Almighty.

"How different is the position of matters in this respect in our day!—when the cautious naturalist receives and adopts with the greatest reserve the statement of fixed and permanent specific characters as belonging to the different forms of organized beings, and is fully persuaded of the constant tendency to variation which all species show even in the present condition of the earth, and of the still greater liability to change which must have existed in the earlier periods of its formation—when the belief prevails that so far from being the direct product of distinct acts of creation, the various forms of plants and animals have been gradually evolved in a slow gradation of increasing complexity; and when it is recognized by a large majority of naturalists that the explanation of this wonderful relation of connection between previously-existing and later forms is to be found in the constant tendency to variation during development and growth, and the perpetuation of such variations by hereditary transmission through successive generations in the long but incalculable lapse of the earth's natural mutations. These, as you must all be aware, are in their essential features the views now known as Darwinism, which were first simultaneously brought forward by Wallace and Darwin in 1858, and which, after being more fully elaborated in the works of the latter and ably supported by the former, secured, in the incredibly short space of ten or twelve years, the general approval of a large portion of the scientific world. The change of opinion is, in fact, now such that there are few scientific works on natural history, whether of a special or more general character, in which the relation which the facts of science bear to the newer doctrines is not carefully pointed out; that, with the general public too, the words 'Evolution' and 'Development' have ceased to excite the feelings, amounting almost to horror, which they at first produced in the minds of those to whom they were equally unfamiliar and suspicious; and that even in popular literature and ephemeral effusions direct or metaphorical illustrations are drawn in such terms of the Darwinian theory as 'struggle for existence,' 'natural selection,' 'survival of the fittest,' 'heredity,' 'atavism,' and the like.

"It cannot be doubted that in this country, as on the Continent, the influence of authority had much to do with the persistence of the older teleological views; and, as has been well remarked by Haeckel, one of the ablest and keenest supporters of the modern doctrine, the combined influence more especially of the opinions held by three of the greatest naturalists and biologists who have ever lived, viz., Linnæus, Haller, and Cuvier, men unsurpassed in the learning of their time, and the authors of important discoveries in a wide range of biological science, was decidedly adverse to the free current of speculative thought upon the more general doctrines of biology. And if it were warrantable to attribute so great a change of opinion as that to which I have adverted as occurring in my own time to the influence of any single intellect, it must be admitted that it is justly due to the vast range and accuracy of his knowledge of scientific facts, the quick appreciation of their mutual interdependence, and above all the unexampled clearness and candor in statement of Charles Darwin.

"But while we readily acknowledge the large share which Darwin has had in guiding scientific thought into the newer tracts of biological doctrine, we shall also be disposed to allow that the slow and difficult process of emancipation from the thralldom of dogmatic opinion in regard to a system of creation, and the adoption of large and independent views more consistent with observation, reason, philosophy, and religion, has only been possible under the effect of the general progress of scientific knowledge and the acquisition of sounder methods of applying its principles to the explanation of natural phenomena."

President Thomson's address concludes with the following words: "I consider it impossible, therefore, for any one to be a faithful student of embryology, in the present state of science, without at the same time becoming an evolutionist. There may still be many

difficulties, some inconsistencies, and much to learn, and there may remain beyond much which we shall never know; but I cannot conceive any doctrine professing to bring the phenomena of embryonic development within a general law which is not, like the theory of Darwin, consistent with their fundamental identity, their endless variability, their subjugation to varying external influences and conditions, and with the possibility of the transmission of the vital conditions and properties, with all their variations, from individual to individual, and, in the long lapse of ages, from race to race.

"I regard it, therefore, as no exaggerated representation of the present state of our knowledge to say that the ontogenetic development of the individual in the higher animals repeats in its more general character, and in many of its specific phenomena, the phylogenetic development of the race. If we admit the progressive nature of the changes of development, their similarity in different groups, and their common characters in all animals, nay, even in some respects in both plants and animals, we can scarcely refuse to recognize the possibility of continuous derivation in the history of their origin; and however far we may be, by reason of the imperfection of our knowledge of paleontology, comparative anatomy, and embryology, from realizing the precise nature of the chain of connection by which the actual descent has taken place, still there can be little doubt remaining in the mind of any unprejudiced student of embryology that it is only by the employment of such an hypothesis as that of evolution that further investigation in these several departments will be promoted so as to bring us to a fuller comprehension of the most general law which regulates the adaptation of structure to function in the universe."

THE DECLINE OF PARTIES.

We print the able and suggestive essay of Prof. Goldwin Smith on "The Decline of Party Government." He opens an interesting question, which, in one shape or another, is bound to force itself more and more upon thinking people. The customary short logic of the case is that we cannot have government without politics, and we cannot have politics without partisanship; this is, therefore, a necessary thing, which must hold the same ascendency in the future that it has held in the past, so that all ideas of doing without it are futile, and all inquiries respecting its decline superfluous. We do not suppose that political parties are to cease, or that partisans have the slightest occasion for anxiety respecting their continuance; but we do not believe that the future is to repeat the past in this matter. The progress and diffusion of science, the formation of scientific habits of thought, and an increasing faculty of observing and reasoning directly upon the facts of life, are going to interfere materially with the ideas and interests of politics. Thus far politics has been a blind and bungling art, necessary indeed, but so crude, loose, and wasteful in its practices, and so much a matter of rule-of-thumb, and transient experience, and the manipulation of men, that all idea of far-reaching principles in the political sphere is currently scouted. Yet this is not the region of chaos, and there are laws in political phenomena, deeper than legislative enactments. These are to be gradually worked out into scientific expression, and in proportion as this is done political partisanship must undergo important modification. It may be, as Prof. Smith assumes, that partisanship must decline for lack of serious issues upon which multitudes of men can be kept in proper antagonism. But we calculate upon a growing dissatisfaction with the methods by which the most valid political

questions are dealt with. The assertion of principles and the advocacy of measures must continue to be indispensable, and there cannot fail to be differences of opinion; but partisan ethics demands denial as well as affirmation, and denial as a matter of policy. It provides for opposition, and of course dreads acquiescence and agreement. As a work of dealing with serious questions, this policy cannot continue to command respect. Indeed, there is already a growing disgust in the community at the emptiness and futility and humbug of political partisanship. Men of honest purposes and fair discrimination will not go to the polls to vote unless overborne and swept along by a factitious excitement. We are told that good men should attend primary meetings, so as to rescue politics from the corrupt hands into which it has fallen. But it is a grave question whether it has not fallen into such hands by the necessary laws of partisanship. What is the chance of a plain, honest man, accustomed to open dealing, in a caucus or convention against the skilled intriguers, the practised wire-pullers, and the disciplined managers, who fill the air with their cries of "reform," and outdo everybody in their zeal to purify politics? The stealthy, long-headed calculator beats the man of inexperience at every tack and turn; and party politics is peculiarly the field where craft, manœuvre, and strategy, have their unhindered way. This is being increasingly recognized, and there is coming with it a deepening distrust of partisan agency. To get everything decent out of politics as quickly as possible is now the open demand. Courts, schools, prisons—all the important agencies of society—must, it is admitted, be taken out of politics, if their purity and efficiency are to be maintained; and even the chief office-holder of the nation heads a crusade to get all the office-holders of the country out of politics. Citizens may be expected to imitate this good example, and more and more get out of politics themselves.

FURTHER ASTRONOMICAL DISCOVERIES.

THE luck of successful research seems now with the astronomers. Last month we announced the brilliant discovery of oxygen in the atmosphere of the sun by Prof. Henry Draper; and we have now to chronicle the equally brilliant discovery of two satellites of Mars by Prof. Asaph Hall, of the Naval Observatory at Washington; and also of a third moon of Mars discovered ten days later by Profs. Henry Draper and E. H. Holden at the private observatory of the Drapers, at Hastings-on-the-Hudson. We publish an interesting article, by Prof. Daniel Kirkwood, on "Mars and his Satellites," giving an account of the growth of our knowledge of the planet and the particulars of Prof. Hall's discovery of his moons.

As Prof. Kirkwood remarks, the question whether Mars had a satellite, which has now been so remarkably resolved, has long interested astronomers. How they have regarded it may be illustrated by the following passage from the third edition of Mr. Chambers's admirable "Hand-book of Descriptive Astronomy," published this year:

"As far as we know, Mars possesses no satellite, though analogy does not forbid, but rather, on the contrary, leads us to infer the existence of one; and its never having been seen, in this case at least, proves nothing. The second satellite of Jupiter is only $\frac{1}{13}$ of the diameter of the primary, and a satellite $\frac{1}{13}$ of the diameter of Mars would be less than one hundred miles in diameter, and therefore of a size barely within the reach of our largest telescopes, allowing nothing for its possibly close proximity to the planet. The fact that one of the satellites of Saturn was only discovered a few years ago renders the discovery of a satellite of Mars by no means so great an improbability as might be imagined."

LITERARY NOTICES.

EXPERIMENTAL SCIENCE SERIES FOR BEGINNERS. LIGHT: a Series of Simple, Entertaining, and Inexpensive Experiments in the Phenomena of Light, for the Use of Students of every Age. By ALFRED M. MAYER and CHARLES BARNARD. New York: D. Appleton & Co. Pp. 112. Price, $1.

THE expensiveness of apparatus has long been felt as a formidable difficulty in the effort to make scientific education popular and practicable. There is double hindrance here; the instruments of experiment are so costly that they cannot be procured for common use, and because of this expensiveness they have to be kept in careful charge, so that ordinary pupils cannot use them, and must content themselves merely to look on and see others work. But what is wanted indispensably is, that all the students shall be themselves put to work; shall be set to making experiments, and observing and proving things for themselves. The obstacles to such a course have hitherto been so great and so general that pupils have had but little chance to cultivate manipulation; and but few schools, in fact, have been able to procure the instruments requisite for demonstration on the part of the teacher. To remedy these difficulties and point out not only how scientific apparatus for physical experiments can be cheaply made, but how much the pupil can do to help himself in the matter, Prof. Mayer, of the Stevens Polytechnic Institute, has undertaken a series of little books, of which the first is now published. His choice of a subject to begin with is most fortunate. The phenomena of light are at once familiar and attractive, are always available, and admit of appliances for illustration of the most simplified and inexpensive character. We give ample illustrations of this in another article of the MONTHLY, from which the reader will see how much can be done in the way of careful experimental work for the illustration of the principles of optics, with but a small outlay of money and but little trouble.

The authors say in the preface: "It is believed that this book will occupy a place hitherto unfilled in scientific literature. It is specially prepared for the boy or girl student and for the teacher who has no apparatus, and who wishes his pupils to become experimenters, strict reasoners, and exact observers. Nearly all the experiments described are new, and all have been thoroughly tested. The materials employed are of the cheapest and most common description, and all the experiments may be performed at an expense of less than fifteen dollars. The apparatus is at the same time suitable for regular and daily use in both the home and school, and with care should last for years."

It is proper to add, in explanation of the joint authorship of the work, that Prof. Mayer has been long busy in inventing simple and cheap apparatus to help teachers and pupils in the art of experimenting; but, being greatly occupied with his professional duties, he made an arrangement with Mr. Charles Barnard to assist him in preparing his results for the press. All the contrivances and inventions for illustrating experiments belong to Prof. Mayer; Mr. Barnard has attended to the detail in the execution of the book, while Prof. Mayer has maintained a close supervision of the work.

REPORT OF THE COMMISSIONER OF FISH AND FISHERIES. Part III., for 1873–'74 and 1874–'75. Washington: Government Printing-Office.

IN this report Prof. Baird gives the results thus far obtained in the inquiry into the decrease of food-fishes, and the efforts to protect and propagate them in American waters. The work in which the commission is engaged is an important one; it has been pushed with vigor, and with results which upon the whole are encouraging. The extent to which fish can be made to contribute to the food-supply is not generally appreciated. It is not alone the fisheries of the coasts and the Great Lakes that may be made to have value, but every mile of river and creek, and every pond and even ditch, may, with proper management, be made to contribute toward supporting a stock of fish. They manage these things better in China, and have carried pisciculture to an extent unknown among Western nations.

Many of the indigenous game-fish decline to adapt themselves to the changed

conditions resulting from civilization—they gradually disappear from the streams, and even if they did not are often greedy, carnivorous savages, who effectually bar a great increase of numbers, especially in small waters. They must be replaced by species that take more kindly to cultivation—that may be domesticated. The trout seems well adapted to pond-culture, and its merits are well known. Prof. Baird also ranks the European carp very highly in this connection, and believes that for propagation in ponds and sluggish waters, both North and South, it will excel all others. Its good qualities are: fecundity and adaptability to the processes of artificial propagation; hardiness, rapid growth, and ability to populate waters to their greatest extent; harmlessness in relation to other fishes, living largely on a vegetable diet; and good table qualities.

The volume is largely occupied by supplementary papers of unequal value: accounts of the fish-industries of other ages and countries; reports of the special efforts to transport fish, lobsters, etc., to and from California, and to Europe; and an appendix devoted to the natural history of the subject. A systematic list of food-fishes, with descriptions and some account of their range, seasons, etc., would be a valuable and much-needed contribution to common knowledge. We hope it will be possible for Prof. Baird to carry out his partial promise to issue such a work in such a way that it will be obtainable by the general public.

ANCIENT SOCIETY: OR, RESEARCHES IN THE LINES OF HUMAN PROGRESS FROM SAVAGERY THROUGH BARBARISM TO CIVILIZATION. By LEWIS H. MORGAN, LL. D. New York: Henry Holt & Co., 1877. Pp. 560. Price, $4.

MANY of the obscure problems of ethnology are here analyzed and discussed with a wealth of learning which renders the work a valuable one for both the student and general reader. In the opening paragraph the author affirms the great antiquity of mankind upon the earth, and proceeds to illustrate the extreme rudeness of their early condition and the gradual evolution of their mental and moral powers through the slow accumulations of experience. The facts presented throughout the work show that the progress of mankind has been from the bottom of the scale, and that "the theory of human degradation, to explain the existence of savages and barbarians, is no longer tenable." It is shown that human progress has been essentially continuous, and that there is a common principle of intelligence in the savage, the barbarian, and the civilized man. As a consequence of this, the same results have appeared at all times and in all areas under the same ethnical conditions. "The roots of modern institutions," the author observes, "are planted in the period of barbarism, into which their germs were transmitted from the previous period of savagery. They have had a lineal descent through the ages with the streams of the blood, as well as a logical development."

The subject is considered by the author under these four heads: 1. Growth of Intelligence through Inventions and Discoveries; 2. Growth of the Idea of Government; 3. Growth of the Idea of the Family; 4. Growth of the Idea of Property.

In the discussion of each of these the reader is made familiar with the successive phases of culture which society has passed through in the course of its development. These phases are, as defined by the author, savagery, barbarism, and civilization, constituting three grand ethnical periods in the progress of mankind. Savagery, the term applied to the lowest status, extends from the period in which mankind were without arts or definite social organizations to that in which they had attained something of both. With the close of the period of savagery that of barbarism begins. At this period the art of making pottery had been developed; the bow and arrow, and implements of flint and stone, were in use. The ethnical period of barbarism is subdivided, as is that of savagery, into three stages, representing characteristic phases of culture. It began with the simple arts referred to, and ends with the invention of a phonetic alphabet and the use of writing in literary composition. In this stage of culture are placed the Grecian tribes of the time of Homer, and the Germanic tribes of the time of Cæsar. Civilization begins with the close of barbarism. It will not be inferred that the transition from one status

of society to another has been sharp or sudden. "Time has been an essential element in the formation of these strata."

The various lines along which development has taken place are thus summarized: 1. Subsistence; 2. Government; 3. Language; 4. The Family; 5. Religion; 6. Home-Life and Architecture; 7. Property. In the author's plan each of these lines is followed in detail, and the characteristic features of each in the successive stages of culture are presented in their order. Thus *subsistence* is shown to have been at first upon fruits and roots. Next in order came fish, then farinaceous substances; later, meat and milk; and lastly arose agriculture. It is obvious that food and the methods of procuring and preparing it have direct relation to culture, so that the status of a primitive people may be determined very nearly by that standard.

The author's elaborate discussion of the genesis of the family will be read with close attention, and will doubtless excite criticism. We can only in the briefest manner state without comment some of the aspects and forms of the primitive family as presented in the work. The lowest status of society is characterized by promiscuous intercourse. The next stage was intermarriage of brothers and sisters. Out of this arose the consanguineous family, or family representing consanguinity and affinity, giving rise finally to the organization of the family on the basis of sex. In this a check was given to the intermarriage of brothers and sisters, and following this occurred marriage between single pairs. A higher stage was the patriarchal family arising from pastoral life. Lastly arose the monogamian family, in which paternity of children is assured, with ownership of property, and lineal descent.

Throughout the work it is made apparent that the earliest steps in progress were taken with difficulty, and required a long period of time. But changes became more rapid as society advanced. If 100,000 years be assumed as the period of man's existence on earth, 60,000 years, on the theory of progressive development, must be assigned to savagery, 20,000 years to the lower stage of barbarism, 15,000 years to the middle and upper stages of barbarism, leaving but 5,000 years for the period of civilization. It would thus appear that during three-fifths of the whole human period man was scarcely more than a child. Whatever changes of fact or of conclusion future inquiries may render necessary in the present work, it will remain a monument of the painstaking labor of the author.

PRINCIPLES OF THEORETICAL CHEMISTRY, WITH SPECIAL REFERENCE TO THE CONSTITUTION OF CHEMICAL COMPOUNDS. By IRA REMSEN, M. D., Ph. D., Professor of Chemistry in the Johns Hopkins University. Philadelphia: Henry C. Lea, 1877. Pp. 231. Price, $1.25.

THIS is a contribution to chemical literature of special fitness and importance at the present time, when the science is passing into a new stage. Prof. Remsen devotes himself to the theoretical aspects of what is called the new chemistry, which he treats with discrimination, presenting its claims with clearness and weighing its defects with fairness. He aims to show exactly upon what basis our present conceptions of chemical constitution rest. The need of a sifting discussion of the subject is assumed to rest upon the fact that the more recent views, be they good or bad, are held by nearly all the working chemists of the day. In regard to the execution and purposes of his book, the author remarks in his preface: "The subject is, of course, not exhausted; many things have purposely been left out, either because they have not yet reached such a stage of development as to entitle them to a place among the fundamental principles, or because it was thought better to emphasize more strongly those principles which are treated. Should the reader miss anything which he expected to find, he will please carefully consider whether the grounds referred to are a sufficient excuse for the omission. The imperfections that will be noticed are, partly at least, due to the imperfection of our knowledge on some of the subjects discussed. For instance, it seems to be impossible for us at present to treat the subject of valence in such a way as to lead to satisfactory results, mainly for the reason that we know so little in regard to it. Whatever view of this property one may take, he will find some difficulties which he cannot surmount."

PHYSIOLOGICAL ÆSTHETICS. By GRANT ALLEN, B. A. Pp. 283. New York: D. Appleton & Co. Price, $1.50.

PROF. ALLEN dedicates this book to Herbert Spencer as "the greatest of living philosophers," and, as might be expected from this, he treats his subject from the point of view of Spencer's philosophy and the law of evolution. This is only another exemplification of the power of a great principle, when newly introduced into thought, of modifying old beliefs and methods of study. Mr. Bain took up the investigation of the human mind more closely from the physiological side than had been before attempted in any general exposition; but he could not link psychology to physiology without bringing it more completely into the current of scientific progress. Hence, when the doctrine of evolution was accepted, physiology underwent a philosophical change which was so powerfully felt in psychology that Prof. Bain had to revise his methodical works to bring them into harmony with it. As æsthetics is occupied with a certain order of human feelings, its roots must be found in physiology, and Prof. Allen's book is an attempt to trace out the connection. We shall review this work more fully in the future, but may here remark that it has been received with great interest and very cordial approval abroad. There are various opinions as to the completeness of his analysis, and the sufficiency of some of his reasonings, but it is agreed that he has opened the subject in a broad aspect, and in a direction that must be pursued by future thinkers. The London *Examiner* thus refers to the work in the opening of its review:

"Among the branches of human activity which the growing science of physiology is destined to illuminate, the fine arts certainly have a place. In proof of this we need refer only to the work of a single living physiologist, H. Helmholtz. Of the importance of this thinker's physiological contributions to the theory of musical art it is unnecessary to speak. It may not be so widely known that this same physiologist has recently published an instructive essay, illustrating the bearing of optical science on the art of painting. This invasion of the region of æsthetics by natural science will be regarded as an evil by all those who suppose that this territory should be infolded in a mist of super-subtile metaphysical fancy. To those, however, who ask for a clear and well-defining daylight in all domains of inquiry, the new direction of physiological labor will be welcome. If anything is likely to supply a firm objective basis for æsthetic rules it is physiological science. Mr. Grant Allen distinctly recognizes this, and his volume is a valuable attempt to add to the physiological foundations of art.

"Our author begins with a timely protest against the unscientific idea, apparently countenanced by Mr. Ruskin, that the pleasures of art are not susceptible of exact explanation. He holds that æsthetic enjoyments, like all other pleasures, may be brought under simple principles or laws of nervous action. Moreover, he goes further, and, by help of the new science of organic evolution, seeks to explain how it is that our nervous system has become so constituted as to respond in a pleasurable or painful manner to the various sensory stimuli. In this way he hopes to arrive at a complete answer to the question regarded as insoluble by Mr. Ruskin, 'Why do we receive pleasure from some forms and colors, and not from others?'

"The physiological method of study cannot as yet be safely carried into the discussion of art-effects beyond the simple sensations of tone, color, etc. The physiological conditions of the more complex delights of intellect and emotion are not as yet accessible. It is a question, indeed, whether as yet the physiological method is adequate to explaining all the æsthetic pleasure of tone and color, and their combinations. This, however, is the task which Mr. Allen sets before himself. He devotes the greater part of his space to the elementary pleasures of art, illustrating these, as is fitting, by a general review of the phenomena of pleasure and pain in the lower bodily regions and in the various senses. Following most recent writers on the subject, he connects pain with the destructive or injurious action of an organ, pleasure with the normal action corresponding to the amount of energy stored up at the time."

BULLETIN OF THE GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES (Hayden's). Volume III., No. 1. Pp. 185. With Plates. Washington: Government Printing-Office.

IN this number of the "Bulletin" are contained twelve papers, mostly on subjects anthropological and entomological. Among them is one by the Rev. M. Eells, on the Twana Indians of the Skokomish Reservation, in Washington Territory. This is an instructive account of the condition of a tribe of Indians in the transition state from savagism to semi-civilization.

RECENT PROGRESS IN SANITARY SCIENCE. By A. R. LEEDS. Pp. 22. Salem: printed at the Salem press.

THE progress made in sanitary science during recent years consists, according to

Prof. Leeds, first, in an increased knowledge of what constitutes clean air, clean water, clean food, and clean environments, on the one hand, and on the other hand what constitutes filth in air, filth in water, filth in food, and filth in our environments, whether it be filth mineral, vegetable, or animal; and, secondly, in a better knowledge of the means of preserving cleanliness and repressing filthiness.

BULLETIN OF THE GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES (Hayden's). Vol. III., No. 3. Pp. 105. With Plates. Washington: Government Printing-Office.

BESIDES a series of five paleontological papers by Dr. C. A. White, this number of the "Bulletin" contains a brief essay by E. A. Barber on the "Utah Dialects." Also, one by P. Schumacher on "Method of Making Stone Implements." There is a paper by Dr. Coues on "Insectivorous Mammals;" one by Lieutenant McCauley on the "Ornithology of the Red River of Texas;" a "Catalogue of Land and Fresh-Water Shells," by S. Aughey, Ph. D.; finally, "Notes on the Geographical Work of the Survey," by A. D. Wilson.

ANNUAL REPORT OF THE MASSACHUSETTS STATE BOARD OF HEALTH. Pp. 520. Boston: A. J. Wright, State Printer.

THE Massachusetts health reports, of which this volume is the eighth, form a series of public documents hardly equaled for the wealth of important information which they contain. The "Special Reports" on sanitary subjects comprised in the present volume are seven in number, and treat of "Pollution of Streams, Dispersal of Sewage, etc.;" "Sewerage;" "Sanitary Condition of Lynn;" "Registration of Deaths and Diseases;" "Growth of Children;" "Disease of the Mind;" and "Health of Towns." It is only by unceasing iteration of the lesson that filth is the great cause of disease, that the local authorities of towns and cities can be aroused to a sense of the danger of allowing insanitary conditions to persist. This lesson is inculcated with much force and thoroughness of research in some of the special reports named above.

ART-EDUCATION APPLIED TO INDUSTRY. By GEORGE WARD NICHOLS. Pp. 211. With numerous Illustrations. New York: Harper & Brothers. Price, $4.

THE title of this work sufficiently indicates its purpose, which is to promote among the people an acquaintance with the principles of art as applied to the products of industry. The author would have these principles taught in all grades of our schools, and offers a scheme of a progressive course of art-instruction which he thinks might easily be adopted by directors of schools in this country. He gives an account of the present state of art-education in sundry European countries, and especially commends the programme of art-education in use in the public schools of Belgium. The work is profusely illustrated.

LINEAR PERSPECTIVE. Part I. By F. R. HONEY. Pp. 36. With Plates. New Haven: Judd & White. Price, $1.25.

THE author of this little treatise, who is instructor in Descriptive Geometry and Perspective in the Sheffield Scientific School, here presents to the student, with all needed clearness, the leading principles of Linear Perspective in the space of a very few pages, and then proceeds to make application of them to perspective drawing. The course of instruction advances by easy steps from the construction of the perspective of a point situated in the horizontal plane to the construction of the perspective of a groined arch and its shadows, and of a spiral stairway.

ANNUAL RECORD OF SCIENCE AND INDUSTRY FOR 1876. By SPENCER F. BAIRD. Pp. 845. New York: Harper & Brothers. Price, $2.

THE "Annual Record," which from the first has been recognized as the very best work of its kind anywhere published, continues to give evidence of the skill and care of its editor. The volume for 1876 contains some notable improvements on all its predecessors. One valuable feature now added is the index of authors and subjects, appended to the "General Summary." Another is the prefixing of the names of Prof. Baird's principal collaborators to the chapters of the "General Summary," written by them. The chapter on "Astronomy" is by Prof. Holden, that on "Meteorology" by

Prof. Abbe, "General Physics" by Prof. Barker, "Chemistry" by the same, "Geology" by Prof. T. Sterry Hunt, and so on, the different departments of "Scientific and Industrial Progress" being attended to by writers of recognized competence. In compiling the second division of the volume, which consists of condensed abstracts of papers on scientific and industrial work, the editor has been assisted by a strong corps of writers, among whom we may name Profs. F. W. Clarke, Cope, F. V. Hayden, Major Powell, and Lieutenant Wheeler.

PUBLICATIONS RECEIVED.

Bible of Humanity. By J. Michelet. New York: Bouton. Pp. 374. Price, $3.

Engineering Construction. By J. E. Shields. New York: Van Nostrand. Pp. 138. Price, $1.50.

Sanitary Condition of Dwelling-Houses. By G. E. Waring, Jr. Van Nostrand. Pp. 145. Price, 50 cents.

Inorganic Chemistry. Vol. II., Metals. By T. E. Thorpe. New York: Putnam's Sons. Pp. 406. Price, $1.50.

Weighing and Measuring. By H. W. Chisholm. New York: Macmillan. Pp. 208. Price, $1.50.

"The Jukes." By R. L. Dugdale. New York: Putnam's Sons. Pp. 121. Price, $1.25.

Daily Bulletin of the Signal Service. With Charts. Washington: Government Printing-Office. Pp. 185.

The Locust Plague in the United States. By C. V. Riley. Chicago: Rand, McNally & Co. Pp. 236. Price, cloth, $1.25; paper, $1.

Physical Geography. By A. Geikie. New York: Macmillan. Pp. 391. Price, $1.75.

General History of Connecticut. By Rev. S. Peters. New York: Appletons. Pp. 285. Price, $1.50.

Report of the Milwaukee School Board. Milwaukee: Keogh print. Pp. 396.

Compendium of Facts and Events. By E. Emery. Peoria, Ill.: *Transcript* print. Pp. 517. Price, $8.

New Constructions in Graphical Statics. By H. T. Eddy. New York: Van Nostrand. Pp. 62. Price, $1.50.

Telegraphic Determination of Longitude. By Lieutenant-Commander F. M. Green, U. S. N. Washington: Government Printing-Office. Pp. 102.

Metallurgical Review. Vol. I., No. 1. Monthly. New York: David Williams. Pp. 100. Price, $5 per year.

Report of the Peabody Museum. Cambridge: Printed by order of the Trustees. Pp. 167.

Brooklyn Monthly. G. F. Beecher, editor. Vol. I., No. 2. Pp. 18. Price, $1 per year.

Relations of Pain to Weather. By Dr. S. W. Mitchell. Philadelphia: Collins print. Pp. 25.

Photograph of the Trotting Horse Occident. By Muybridge. San Francisco.

Fishes of Upper Georgia. By D. S. Jordan. Salem Press print. Pp. 70.

Molecule and Atom. By G. F. Barker. From Proceedings of American Association. Pp. 23.

Heredity. By Dr. E. N. Brush. Buffalo: Hausman & Barow print. Pp. 12.

Personal Appearance. By T. S. Sozinskey, M. D. Philadelphia: Allen, Lane & Scott. Pp. 196. Price, $1.25.

Materialism and Pedagogy. By W. H. Wynn. Gettysburg, Pa.: Wible print. Pp. 22.

Brain of Procamelus Occidentalis. By E. D. Cope. Pp. 4. With Plate.

Green River Shales. By E. D. Cope. Pp. 10.

Rationale of compressing Cotton. By S. H. Gilman. New Orleans: Hyatt print. Pp. 52.

Lectures and Essays. By Dr. V. W. Blanchard. New York: Blanchard Food-Cure Company. Pp. 67. Price, 10 cents.

Hay-Fever. By Dr. E. J. Marsh. Newark, N. J.: Hardham print. Pp. 26.

New Method in Solar Spectrum Analysis. By S. P. Langley. From *American Journal of Science and Art*. Pp. 6.

Anglo-American Primer. By Elieza Bœrdman Burnz. New York: Burnz & Co., Fonetic Publishers. Price, 15 cents.

Annual Meeting of the Free Religious Association (1877). Boston: The Association. Pp. 95. Price, 40 cents.

Venous Circulation. By Dr. W. F. Glenn. Nashville: Marshall & Bruce print. Pp. 4.

Pacific School and Home Journal. Vol. I., No. 6. San Francisco: Lyser & Co. Monthly. Pp. 40. Price, $2 per year.

Darwin on Fertilization of Flowers. By T. Meehan. From *Penn Monthly*. Pp. 10.

The Glacial Period in the Southern Hemisphere. By T. Belt. From London *Quarterly Journal of Science*. Pp. 30.

Serpent and Siva Worship. By Hyde Clarke and C. S. Wake. New York: Bouton. Pp. 48. Price, 50 cents.

The American Bison. By J. A. Allen. Washington: Government Printing-Office. Pp. 144.

A Scientific Course of Study. By C. E. Bessey. Grinnell, Iowa: *Aurora* print. Pp. 11.

Electrical Conduction. By R. C. Kedzie. Pp. 8.

Criminality. By Dr. W. G. Stevenson. From the *Sanitarian*. Pp. 23.

Glacial Ice Deposits. By G. Sutton. From Proceedings of American Association. Pp. 7.

American Homœopathist (monthly). Vol. I., No. 1. Chicago: Chatterton & Co. Pp. 40. Price, $2 per year.

Notes from the Chemical Laboratory of Johns Hopkins University. Pp. 16.

Proceedings of the Davenport Academy of Sciences. Vol. II., Part I. Davenport *Gazette* print. Pp. 148. Price, $3 per volume.

Inscribed Tablets from Davenport, Iowa. Pp. 22. With Plates. From the same.

Heredity, Pauperism, and Crime. By Dr. E. H. Parker, of Poughkeepsie, N. Y. Pp. 12.

School Discipline. By J. Kennedy. Syracuse, N. Y.: Davis, Bardeen & Co. Pp. 23.

Electrometers. By J. T. Bottomley. New York: Macmillan. Pp. 33. Price, 20 cents.

Veratrum Viride. By Dr. J. S. Lynch. Baltimore: Innes & Co. print. Pp. 8.

POPULAR MISCELLANY.

THE American Association for the Advancement of Science met at Nashville, Tennessee, on Wednesday, August 29th, Prof. Simon Newcomb presiding. The sessions continued for four days. Prof. O. C. Marsh, of Yale College, was elected President of the

Association for the present year; Prof. R. H. Thurston, of the Stevens Technological Institute, Hoboken, Vice-President of the Physical Section; Prof. Augustus R. Grote, Vice-President of the Section of Natural History; Prof. H. Carrington Bolton, of Columbia College, New York, General Secretary; Prof. Francis E. Nipher, St. Louis University, Secretary of Section A; George Little, Atlanta, Georgia, Secretary of Section B; William S. Vaux, Philadelphia, Treasurer; chairman of Chemical Sub-section, Prof. F. W. Clarke, of the University of Cincinnati. The Association will meet next year in St. Louis, on the third Wednesday of August. The address of Prof. O. C. Marsh, as Vice-President of Section B, at the Nashville meeting, on the "Introduction and Succession of Vertebrate Life in America," was a paper of extraordinary interest, embodying the results of its author's fruitful researches into the paleontology of this continent. Prof. Grote advocated the creation of an International Scientific Service, or organization for the advancement of knowledge. We shall in future numbers of the MONTHLY publish abstracts of some of the more interesting papers read at this meeting of the Association.

The Cinchona Alkaloids.—Of all the species of cinchona-trees planted in the Nilgiri Hills district of India, the red-bark, or *C. succirubra*, has succeeded best; indeed, none of the other species appear to thrive in the Nilgiri plantations, and they are rapidly giving way before the red-bark cinchona-tree. The bark of the latter contains only a small proportion of the alkaloid quinine as compared with the other three principal alkaloids — cinchonine, cinchonidine, and quinidine—and hence the promise of an abundant supply of the first-named alkaloid from the Indian plantations is not fulfilled. Hence, if the febrifuge properties of the cinchona were confined to the alkaloid quinine, we should have to pronounce these plantations a failure. But it appears to be still an open question whether quinine is entitled to this preëminence. Indeed, there is good reason for believing that the kind of bark which earned for the cinchona-tree its reputation had for its predominant alkaloid cinchonidine. Within a few years, medical commissions have been appointed in Madras and Bombay to determine the respective values of the four alkaloids as febrifuges. The result arrived at by the Madras commission, as stated by Dr. B. H. Paul, in a paper read before the London Society of Arts, was to the effect that, "in recent cases of uncomplicated paroxysmal fever, there did not seem to be any great superiority of one cinchona alkaloid over another." The numerical results on which the commission founded its conclusions were as follows:

		Cured.
Treated by cinchonine.....	410.....	400
" " cinchonidine....	359.....	346
" " quinidine.....	376.....	365

In subsequent trials these alkaloids were compared with quinine, and the total number of cases treated was 2,472, and of these 2,445 were cured. The ratio of failure per 1,000 cases was as follows:

Quinine.....	7.092
Quinidine.....	6.094
Cinchonidine.....	9.925
Cinchonine.....	23.255

Which appears to show that the first three are nearly equal in their febrifuge properties.

Treatment of the Opium-Habit.—The English Church Mission supports at Hangchow, China, an "opium-refuge," or hospital for the treatment of smokers of opium. The capacity of this hospital, as we learn from the *Journal of Inebriety*, is for about thirty patients, and there are generally about as many applications for admission as can be granted. Persons wishing to be admitted make their applications on or before the beginning of a month; all the patients for one month being admitted on the same day, and remaining in the hospital for three weeks. In this way, twelve classes of patients are turned out each year, and there is one week in each month for cleansing the hospital. The treatment is directed simply to relieving the *malaise* and depression caused by discontinuance of opium, and the physician in charge states that at the end of three weeks the patients can entirely dispense with the drug without physical inconvenience. One strange fact is developed by this benevolent enterprise. Some of the patients enter the refuge without any desire of giving up opium. They have gone so far that a large quantity is required to satisfy

their craving—larger than they can afford to buy. By submitting to hospital treatment they can get back to a point where a moderate quantity of the drug will produce the desired effect. "They only wish to get up-hill, that they may have the pleasure of sliding down again!" Even in his dissipations the Chinaman shows his characteristic wariness.

Silver-bearing Sandstones. — A correspondent of the *Engineering and Mining Journal* describes the "silver sandstone" formation occurring in the vicinity of Leeds, a village in the southwestern corner of Utah, about 300 miles from Salt Lake City. The formation is a beautifully-stratified red and white sandstone, but greatly broken up and eroded. Where the strata have been undisturbed, they rise to a height of perhaps 1,000 feet above the valley in table-mountains, alternately banded with red and white. The numerous foldings and contortions of the strata are accounted for by the presence of many extinct volcanoes, while the great sandy deserts, covered with sage and cactus, bear abundant evidence of the erosion. On the northern side of what was once a vast basin, lying between several ranges of high mountains of old rock, where the erosion of an anticlinal has left ridges or reefs cropping out at various angles, are the mines. The sandstone consists of red and white deposits, carrying some lime as a cementing material, with occasional layers of clayey or shaly rock, and a considerable amount of carbon scattered throughout. The white sandstone seems so far to have carried the ore, but all the strata carry it in greater or smaller quantity. Careful samplings and analyses show that there is a large amount of ore running from $20 to $50 per ton—in several beds, a foot or more in thickness, averaging from $50 to $200, while others have streaks of various widths, from one to ten inches, yielding ore from $200 to $1,200.

Specimens of so-called "silver-mud" from Oregon have been examined by Mr. Henry G. Hawks, member of the California State Geological Society, who found the substance very rich in silver in the free state, though the microscope failed to give any clew to its origin. It has been suspected that this "silver-mud" is an artificial product, intended to subserve fraudulent designs, but Mr. Hawks could not find any evidence of fraud. If the free silver in the mud were filings, a single glance would suffice to detect the fact. Had the silver been precipitated from solution by copper, it would have been crystallized. An amalgam of silver and mercury would have yielded a sublimate if strongly heated in a glass tube closed at one end. Such amalgam introduced into the wet mud, and the whole heated sufficiently to volatilize the mercury, would have left the substance in a hard-baked state, which could not again have been reduced to the state in which the mud was when it came into the hands of Mr. Hawks. The author finds a close resemblance between this "silver-mud" and the silver-bearing "sandstone," so called, of the preceding paragraph.

Anthropology in Germany.—A writer in *Das Ausland* directs attention to the neglect of anthropological research in the great schools of Germany. The science of anthropology, he remarks, together with all its subordinate branches, such as anatomo-physiological anthropology, ethnology, ethnography, "prehistory," and comparative archæology, were substantially founded by German scholars, as Keller and Virchow, Schaaffhausen and Bär, yet hitherto they have been assigned no official place in higher education. There is not in all Germany a single professorship of anthropology, though that is a subject that interests the entire cultured public. "With us," he writes, "the four antiquated Faculties still profess to represent science in its totality. In France, the case is different. Schaaffhausen, in his account of the Prehistoric Congress of Buda-Pesth, observes that in Paris a professorship of anthropology has been in existence for the last twenty-seven years. Besides, we learn of the recent establishment in Paris of a school of anthropology. This school consists of four sections, of anatomy, biology, ethnology, 'prehistory,' and linguistics, with Broca, Jopenard, Dally, Mortillet, and Hovelacque, for professors. In Germany two scientific men lecture on anthropology, namely, Ecker in Freiburg, and O. Jäger in Stuttgart."

Distribution of the Seventeen-Year Locust.—Mr. L. G. Olmstead, of Fort Edward, sends us an account of a recent interview with Dr. Asa Fitch, the distinguished entomologist of Salem, New York, from which we extract the following particulars concerning the habits and geographical distribution of the seventeen-year locust, which has but lately planted the seeds for the crop of 1894:

"The seventeen-year locust, the *Cicada septendecim*—thus named by Linnæus, the prince of natural historians—has just made its regular visit to the woods north of Clark's mills, below Fort Miller Bridge, on the Hudson River. Fort Miller Bridge is their extreme northern limit. From time immemorial they have appeared on the same spots. If the woods are cleared up, they resort to the nearest orchards. They are found from this locality south along the Hudson, on through New Jersey, Delaware, Pennsylvania, Maryland, Virginia, the Carolinas, and Georgia. They come out in immense numbers, the woods resounding with the din of their notes.

"There is an annual *Cicada* which appears in dog-days, whose shrill note is quite different from the seventeen-year locust. The notes of this last are not unlike those of the tree-toad, and they were heard at Clark's mills above the noise of the machinery.

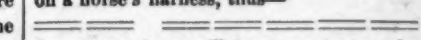
"They sing when the sun shines. When growing old their note is much more feeble. The males alone sing; the females are silent, and this has given rise to the distich:

> 'Happy are the *Cicadas'* lives,
> Because they all have voiceless wives.'

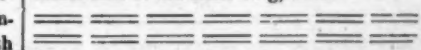
"This is their fourth visit that the doctor has observed. He has gathered and confined scores of them, under netting on an apple-bush to keep them from being devoured by birds, which collect to feed on them in immense numbers, as do the swine, and such wild animals as skunks, weasels, etc.

"The locusts puncture the bark of trees and live on the juice. They do not disturb herbaceous plants. They pierce the twigs and deposit two eggs in each puncture, which are probably male and female. The grub hatches and drops to the ground, into which it is said to go to great depths, and is seventeen years in getting its growth. They sometimes come up in the bottom of newly-dug cellars, and where roads are made across districts they have occupied, and they work themselves up through the hardest beaten highway. On coming out of the ground they immediately pair, and the female commences boring the twigs and depositing her eggs, which occupies her about three weeks, when they die and disappear. They never do any appreciable injury to the trees. This seventeen-year locust is not found in any other part of the world.

"They left Fort Miller about the 25th of June, leaving an appointment to hold another great concert on the same ground in 1894. The twigs of witch-hazel, poplar, maple, hickory, oak, etc., are beautifully punctured and as regularly as the stitches on a horse's harness, thus—



Sometimes there will be two rows on the under side of the same twig, thus—



Many twigs of the oak have died from the punctures.

"There is also a third species of locust in this county, of which only a very few appear. The species of *Cicada* are numerous in warm climates. The doctor has in his collection ninety-two species. He has the three found in this county; others from Pennsylvania, Illinois, Arkansas, Mississippi, Alabama; the Bahama Islands, Jamaica, Venezuela, Brazil, Colombia, Chili; a number from France, Spain, Italy, Egypt, Algiers, Cape of Good Hope, Senegal, Madagascar; the Crimea, Sylhet (a part of British India), Borneo, Java, Ceylon, Assam, Malacca, and New Holland."

Cremation of Dr. Charles F. Winslow.—The following, from a gentleman who took an active part in the cremation of the body of the late Dr. Winslow, at Salt Lake City, on July 31st, contains many interesting details concerning this event not before published:

"Dr. Winslow always had a dread of being buried in the ground; perhaps not a dread, but he had seen many bodies that had suffered the slow decomposition and ravages of the worms, and the thought was disgusting to him. His heart was taken out and embalmed, placed in a jar,

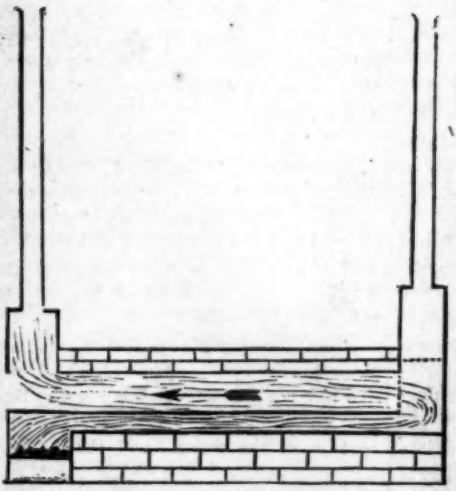
and is to be buried within the grave of his mother. As soon as his executor (and personal friend) reached here, it was decided to proceed with the cremation, but, before it was done, his children at the East intervened, and the operation was delayed. One of his sons came here, and, after reading the will and talking with his (the doctor's) friends, to whom the doctor had so often expressed his views in favor of 'cremation,' decided that it ought to be done, and wrote to the other children for their consent, which they finally granted. In the mean time the body had been embalmed, and kept continually packed in ice.

"Dr. Hamilton, who had charge of the 'cremation,' consulted me as to the means of doing it. They had talked of taking the body to one of the reverberatory furnaces, as they wanted it done quickly—in fact, before his children would know of it. I thought a furnace could be built quickly and cheaply that would answer the purpose, and designed one, as per inclosed rough sketch.

"I will admit that many improvements could have been made on it; but, when you consider that in six hours from the time it was commenced a fire was built in it, I think you will say we did well. Time and expense were the obstacles I had to overcome. The interior of the furnace was six feet by two; the bottom was of boiler-iron, three-eighths of an inch thick; the roof of fire-tiles, two feet long and one foot wide. This enabled us to cover without an arch. The door for the admission of the body was at the south end. You will notice two stacks; the extra one was made so that we could shut off the flames by means of a damper, enabling us to put the body in, and also to view the action without the flame approaching the door. You will see that the flame, when the furnace was at work, passed under the floor the whole length, and then returned over the body and up the stack at the south end of the furnace. In the operation we used the coal from 'Rock Springs,' on the Union Pacific Railroad.

"It was intended to 'cremate' immediately on the completion of the furnace, but Dr. Hamilton had doubts as to the working of the furnace; so he placed in it a quarter of beef, and found it to produce the desired result on this in one hour and five minutes; and, while this was going on, word came to stop it all.

"Finally, all was arranged on the 31st of July; the body, then weighing 126 pounds, was placed on a sheet of iron one-eighth of an inch thick, turned up at the sides and end, and introduced into the furnace, which was at a full-red heat, at 6.20 P. M. The dampers were opened, and the flame allowed to pass directly over the body. For some time quite a '*boiling*' took place, and lasted until most of the moisture had been driven off; in about an hour nearly all the flesh was consumed and the heat was raised. At the end of two and a half hours all action was at an end, but five minutes more was allowed, when the fires were drawn and air admitted to the furnace. In about half an hour the plate was drawn, and the bones gathered up; they were perfectly white and friable, so much so that they could be easily crushed in the hand. After this we rubbed the bones in an iron mortar, and passed them all through a flour-sieve, making in bulk about one quart, and in weight about four pounds. From the time the body was put into the furnace until the ashes were ready for the urn was four hours and forty minutes.



FURNACE IN WHICH THE CREMATION WAS PERFORMED.

"From the construction of the fur-

nace we had perfect control over the heat. I did not wish to have it too hot at the time of placing the body in it for fear of an excessive generation of gases, but I believe we would not have gained anything by having the heat any more intense; from my observation I am convinced that the heat required is not so great as generally supposed: the action of the heat on the lime gives it the appearance of being intensely hot, but at the same time I noticed that the end of the plate where the flame turned was barely altered—just scored a little, as if it had approached nearly to the melting-point.

"The furnace did not cost $100, and I suppose about 1,000 pounds of coal were consumed."

Signs of Advance in Medical Science.—A significant communication has appeared in the English medical journals, namely, a letter to Dr. B. W. Richardson, from George Wyld, M. D., Vice-President of the British Homœopathic Society, in which the latter pleads for a reconciliation between homœopathists and practitioners of the regular school of medicine. Dr. Wyld in effect maintains that the art and science of medicine, as understood by the homœopathists, so called, of England, and by the regular profession, are now the same. Hahnemann, in his famous essay, entitled "The Medicine of Experience," had made no mention of homœopathy, and the doses there recommended were tangible, not infinitesimal. But, as his views were scornfully rejected by the medical profession of the time, Hahnemann, in his turn, became intolerant of the views received by the medical profession, and, "out of spite," as one might say, adopted the doctrine of the efficacy of infinitesimal doses. But everything is now changed, according to Dr. Wyld. "The so-called homœopathists," he writes, "have almost entirely abandoned the use of globules, and have substituted doses in a tangible form. Further, whereas the early homœopathists denounced all auxiliaries in the treatment of disease, it is now the practice to make frequent use of all remedies of a simple kind, such as occasional aperients, anodynes, opiates, anæsthetics, galvanism, hydropathy, Turkish baths, and mineral waters. In short, we define our practice as rational medicine, including the application of the law of contraries, but *plus* the application of the law of similars." Dr. Wyld adds that the sentiments he expresses are held by a large number of homœopathic practitioners. He believes that were physicians of his school to be admitted to the regular medical societies and to the pages of regular medical journals, it would not be long before all sectarianism in medicine would be at an end. He demands the same liberty of opinion in medicine as in religion or politics, and an amalgamation with the regular profession on equal terms. Dr. Richardson asks his brethren to "accept this intended message of peace and goodwill in the spirit in which it is written and offered."

Experiments with Viper-Poison.—In the *Zeitschrift für Biologie*, Valentin states the results of his researches on viper-poison. The particular species of vipers employed was the *V. aspera* of Linnæus. Only one viper out of twenty could be made to bite by external irritation. One viper was made insensible under the influence of ether, and Valentin took the opportunity of squeezing out some of the poison on squares of Swedish filtering-paper; he also obtained some of the transparent mucus which had collected on the palate near the apices of the poison-fangs. A fragment of this paper a few millimetres square placed under the skin of the back of a frog generally caused death in from six to twenty hours, the cause of the fatal results, the author thinks, being due to the admixture of some of the yellow, oily secretion of the poison-gland with the saliva. Paper impregnated with the poison retained its activity for six months or more, and enough was obtained from one animal to saturate twenty pieces of filtering-paper presenting twenty to thirty-five square millimetres of surface. It was found that a quantity of the poison not exceeding 0.00037 of a gramme is capable of producing, when inserted beneath the skin of a frog, well-marked and persistent symptoms of poisoning and death in thirteen days; and quantities varying from one-half to one milligramme killed a frog in from eight to twenty hours.

NOTES.

ACCORDING to an estimate made by the Berlin Statistical Bureau, the total steam motive-power actually in use throughout the world is equal to 13,500,000 horse-power, or to the working force of 25,000,000 horses.

SOME grains of wheat left in Polaris Bay (north latitude 81° 38′) by Captain Hall's expedition, in the year 1872, were carried to England by Captain Nares last year. Though they had been exposed for four years to the intense cold of that high latitude, these wheat-grains germinated on being sown in a pot of earth at the Botanic Garden, Kew.

A PAPIER-MACHÉ coating for the bottoms of iron-ships is proposed by Captain F. Warren, who states that weeds and barnacles will not adhere to this material. The special cement by which it is secured may be applied cold, hardens under water, is unaffected by high temperature, and possesses great tenacity. A plate thus protected on one side was immersed for six months, and then the protected side was found clean, while the unprotected metal was covered with rust and shell-fish.

THE schooner Florence, *avant-courrier* of Captain Howgate's proposed expedition to the north-polar regions, sailed from New London on the 2d of August, with the design of establishing a colony of explorers on the north shore of Cumberland Island. This island forms the western shore of Davis Strait, and lies between parallels 64 and 68 north latitude and between the meridians 62 and 78 west longitude. The party which goes out in the Florence is supplied with provisions sufficient for one year, or until the arrival of the main expedition under Captain Howgate, which is expected to sail in July of next year. The ship's officers and scientific staff of the Florence are as follows: Master, George E. Tyson, of Polaris fame; first-mate, William Sisson; second, Dennison Burrows; steward, Eleazar Cone; meteorologist, Orray T. Sherman; naturalist, Ludwig Kumlin. Mr. Sherman is a graduate of Yale College. Mr. Kumlin is sent under the auspices of the Smithsonian Institution. The vessel's crew consists of picked seamen.

THE first "telephonic line" for practical use has been set up by Mr. C. Williams, of Boston, connecting his place of business in that city with his residence in Somerville, a distance of about three miles. By this line "conversation," Mr. Williams says, "can be carried on nearly as well as if those conversing were in the same room."

THE "Transactions" of the American Society of Civil Engineers for June contains an interesting discussion on the subject of the preservation of timber, besides minutes of meetings and several articles of importance mainly to engineers.

A YEAR or two ago, Prof. Bolton, of Columbia College, had some combustible material in his laboratory set fire to by rays of light concentrated by a globular glass jar filled with water. A similar accident lately occurred in Paris, a number of cartridges being ignited by solar rays concentrated by an "eye" in a window-pane. A terrific explosion resulted. "Similar catastrophes," says *Nature*, "are more common than is generally supposed in summer, the windows of railway-carriages igniting sometimes over-dried plants, or even leaves fallen on railway embankments. It is known that fires sometimes occur in Algerian forests through drops of water suspended to the leaves and forming lenses."

THE climate of Victoria and other parts of the continent of Australia has been highly commended as of benefit to consumptive patients; but the official statistics appear to prove the contrary. From an "Analysis of the Statistics of Phthisis in Victoria," it appears that the disease is as common and as constant in Melbourne and its suburbs as in England, both among the immigrants and the native-born whites.

IN 1843, as we learn from a writer in the *American Naturalist*, a white-maple tree (*Acer dasycarpum*) in the town of Stockbridge, Massachusetts, measured twelve feet in circumference at three feet above the ground. In October, 1876, the tree was, at the same height from the ground, fifteen feet nine inches in circumference. Thus the average annual increase of circumference was about 1.36 inch.

THE London Geographical Society has declined to coöperate with the International Association for the Exploration of Africa founded by the King of the Belgians, and favors independent work by the English. To promote the accomplishment of this work a fund is to be raised, and the Geographical Society has already made a special donation of £500. It is estimated that a well-equipped exploring expedition will cost £1 10s. for every geographical mile of country traveled in Africa.

THE native trees, bushes, and shrubs, of Southern France that are most sensitive to cold during extreme winters are by Martins held to be *survivors* of the flora which covered the same area during the Middle Tertiary; they are exotic as to *time*, as other plants are exotic as to *space*.

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